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Department of the Army
Savannah District
Corps of Engineers

Liquefied Petroleum Gas (LPG) Storage Facility Study Fort Gordon, Georgia

Final Submittal

S-E Project No. 7469B
September 1992

Simons-Eastern Consultants, Inc.

DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
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U. S. Army Engineer District, Savannah
Ft. Gordon LPG Study
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Contents

1. EXECUTIVE SUMMARY

1.1 Introduction

Fort Gordon currently purchases natural gas from Atlanta Gas Light Company under a rate schedule for Large Commercial Interruptible Service. This offers a very favorable rate for "interruptible" gas service, however, Fort Gordon must maintain a base level of "firm gas", purchased at a significantly higher cost, to assure adequate natural gas supplies during periods of curtailment to support family housing requirements and other single fuel users.

It is desirable to provide a standby fuel source to meet the needs of family housing and other single fuel users and eliminate the extra costs for the firm gas commitment to Atlanta Gas Light Company. Therefore, a propane-air standby fuel system is proposed to be installed at Fort Gordon.

1.2 Existing Natural Gas Service

Natural gas service to Fort Gordon is furnished by an 8" main, owned by Atlanta Gas Light Company, that bisects the fort and is also used to deliver

natural gas to private communities neighboring the fort. There are numerous branches off the main that deliver natural gas to all of the natural gas users, both large and small, on the fort. The larger users have already been converted to dual fuel capabilities so they can be switched to fuel oil as their back-up fuel, at times when natural gas is curtailed.

The natural gas fired equipment in family housing and the other, smaller single fuel equipment are not convertible to dual fuel capabilities. To maintain a firm level of natural gas and avoid curtailment of service to these users, Fort Gordon has committed to an additional expenditure that has averaged approximately $830,000 per year for the last four year period from July, 1988, through June, 1992.

1.3 Energy Consumption

Natural gas consumption is measured in therms, with 1 therm equalling 100,000 BTU's per hour in heating value. The natural gas consumption at Fort Gordon has averaged approximately 5.5 million therms per year for the past four year period. Of this total, approximately 4.1 million therms were

purchased at the premium rate for firm gas and only 1.4 million therms were purchased at the more economical interruptible rate.

1.4 Energy Cost Savings Opportunities Investigated

There were a total of seven energy cost savings opportunities investigated using life cycle cost analysis techniques.

The first three opportunities were incremental reductions in the firm gas commitment from the current level to zero, without providing any type of standby fuel system for backup. The cost savings were compared with the potential penalties that could be imposed if excessive or "unauthorized" gas consumption occurred during periods of curtailment.

Two additional opportunities investigated incremental reductions in the firm gas commitment with installation of a "peak shaving" propane-air system to furnish the balance of fuel required during times of natural gas curtailments.

The sixth and seventh opportunities investigated the total elimination of the firm gas commitment and the installation of a "standby" propane-air system to

furnish the total fuel requirements for family housing and other single fuel users at times when natural gas is curtailed. One of these opportunities involved relocation of the existing gas main and the other did not.

1.5 Conclusions and Recommendations

Considerable life cycle cost benefit is available to Fort Gordon with the installation of a propane-air standby system to back-up the natural gas fuel supply and elimination of the requirement to purchase firm gas from the current supplier.

The estimated construction cost is $2,950,000 including SIOH and design cost. This cost includes installation of the propane-air standby system, the initial supply of propane, and relocation of the Atlanta Gas Light main to allow the distribution system on the fort to be isolated from the gas company when service is curtailed and propane-air is to be used as the fuel.

The annual estimate savings is approximately $830,000, the average current premium paid for firm gas.

The savings to investment ratio (SIR) for this opportunity is 5.18 and the simple payback period is 3.36 years.

It is, therefore, recommended that a propane-air standby system be installed, and that a new gas main be constructed across the fort.

It is further recommended that negotiations be conducted with Atlanta Gas Light Company for alternatives to the gas line relocation in order to further enhance the economic benefits of the propane-air standby system.

2. INTRODUCTION

2.1 Overview

All of the family housing at Fort Gordon requires natural gas as the fuel for heating, hot water and cooking. Many of the other facilities at the fort also require natural gas for one or more of these functions, and all of the central heating plants use natural gas as the primary fuel.

Fort Gordon currently purchases all of the natural gas requirements from Atlanta Gas Light Company under a rate schedule for "Large Commercial Interruptible Service". This schedule provides a very attractive rate for "interruptible" gas use, however, it also includes additional charges and much higher rates for "firm use" (i.e. non-interruptible gas). The fort currently has a commitment with Atlanta Gas Light Company to purchase a quantity of up to 13,500 therms per day of natural gas at the "firm use" rate and purchase the balance at the "interruptible" rate.

The premium on the purchase of firm gas amounts to a very sizeable annual expense to Fort Gordon, an expense that the fort would like to significantly reduce or eliminate. Simons-Eastern was, therefore, commissioned by the

Savannah District, Corps of Engineers to conduct a study to determine opportunities available to Fort Gordon to reduce or eliminate the firm gas commitment and expense.

2.2 Project Background

The terms of the agreement between Fort Gordon and Atlanta Gas Light Company allow for the curtailment of the "interruptible" gas service, in whole or in part, after as little as a thirty minute notice from the gas company. At that point the fort must reduce its gas consumption to no higher than the "firm" level. If consumption is not reduced, harsh financial penalties may be imposed for what is considered unauthorized consumption of gas (i.e. all consumption above the firm use commitment).

There are two primary ways to avoid the penalties for the unauthorized consumption of gas. The first is to maintain a high level of firm gas commitment that would not be exceeded during times of curtailment. The second is to reduce natural gas consumption during curtailment, either by temporarily shutting down some gas usages or by providing alternate back-up fuel for some gas usages. The first option results in a high annual cost for firm

gas availability, and the second would require capital expenditures to allow for an alternate fuel.

Fort Gordon already has instituted a program of using fuel oil as a back-up fuel on natural gas burning plants with capacity of 5 MMBTU/Hr. or more. These units have dual fuel firing capabilities. This has allowed for a very significant reduction in natural gas usage during curtailment and has provided Fort Gordon the opportunity to reduce the firm gas commitment to the current level of 13,500 therms per day.

Majority of the gas usage that comprises the current level of firm gas is, therefore, family housing, along with kitchens in the various dinning halls and hot water heating in many buildings. All of the natural gas users in these buildings are relatively small individual units that are not convertible to dual fuel capability. The only reasonable opportunity to reduce or eliminate the dependency on natural gas purchased from the utility is to use an alternate back-up fuel that is compatible with equipment designed to burn natural gas. That alternate fuel is a propane-air mixture.

Many other municipalities, government and private facilities have successfully installed and are using propane-air systems for full back-up or peak-shaving capabilities to reduce their dependency on natural gas supplies from public utilities and have reaped the benefit of significant cost savings. Fort Gordon wants to pursue this option and receive similar benefits.

2.3 Project Scope

The scope of this Liquefied Petroleum Gas (LPG) Storage Facility Study is to determine the opportunities available for Fort Gordon to reduce natural gas expenditures by reducing or eliminating the requirement for firm natural gas from the current supplier. The primary focus of the study, based on previous analysis done by Fort Gordon, is to determine a method for isolating Fort Gordon from the Atlanta Gas Light system and installing a propane-air system as a back-up source of fuel for use when natural gas supplies are curtailed.

2.4 Study Objectives

The objectives of the LPG Storage System Study are to establish an optimum level for the firm gas commitment, and identify the capacities and capital costs

involved to isolate Fort Gordon from the Atlanta Gas Light main, and install a propane-air system a back-up fuel source.

Services and documentation to be provided include:

- Field investigation of family housing and other facilities with natural gas use requirements that do not and will not use fuel oil as back-up to determine the fuel demand to be used in establishing the capacity of the propane-air system.

- Review recent gas consumption records and Atlanta Gas Light Company tariffs.

- Review Defense Fuel Supply Centers (DFSC) contract for possible cost saving opportunities.

- Investigate potential growth at Fort Gordon and the possible affect on the propane-air system.

- Field investigation of new pipeline routing for Atlanta Gas Light gas main.

- Define concept for installation and operation of propane-air plant as alternate fuel or for peak-shaving.

- Provide cost estimates and a preliminary DD Form 1391 for capital expenditures required for implementation of the cost reduction program.

- Conduct life cycle cost benefit analysis for potential cost reduction programs.

- Investigate feasibility of third party ownership of new facilities.

3. DESCRIPTION OF EXISTING FACILITIES

3.1 Overview of Operation

Natural gas is the primary fuel for all operations at Fort Gordon. Natural gas users can be identified in three different categories: 1) family housing, 2) other single fuel users, and 3) central plants and other dual fuel users. The natural gas is provided via a gas main through the fort that supplies natural gas to distribution mains to the different users.

The gas supply is divided into two categories: 1) firm gas, and 2) interruptible gas, with a different tariff for each category. The firm gas will always be available unless catastrophic circumstances occur, but the interruptible gas can be curtailed whenever demand on the capabilities of the gas company become severe. The firm gas is, therefore, sold at a premium price in comparison to interruptible gas.

Fort Gordon must commit to a level of firm gas that will provide fuel to all of the family housing and other single fuel users so gas flow to these users will not be curtailed as these users currently have no back-up fuel source.

3.2 Existing Natural Gas Service

Natural gas service to Fort Gordon is furnished via an 8" underground gas main that enters the fort at Gate 5, traverses along Avenue of the States, Rice Road, Chamberlin Avenue, 15th Street, 13th Avenue, and exits the fort near Gate 3. There are 18 branches off the main that distribute natural gas to the various users within the fort.

The gas main was installed in 1965. It is carbon steel pipe that is coated and wrapped for corrosion protection and further protected by a cathodic protection system that is installed outside of the fort. According to information furnished by the gas company, the pipe is in extremely good condition and has not had a history of leaking.

After crossing the fort and exiting near Gate 3, the gas main continues northward to service private users in the Grovetown, Georgia, area.

The gas main operates at a pressure of 300 psi. Gas pressure is reduced in the branch mains to 75 psi or less and is finally reduced at each user point to the appropriate pressure for that user.

For the purposes of determining natural gas consumption and establishing billings, Atlanta Gas Light Company has two metering points on the fort; an incoming meter station at Gate 5 and an exiting meter station at Gate 3. Natural gas consumption is determined and billed based upon the difference in the accumulative readings at the two metering stations. The metering equipment at both locations is still serviceable, however, the equipment is outdated and has questionable accuracy.

3.3 Natural Gas Rate Schedule

Fort Gordon currently purchases from Atlanta Gas Light Company under Rate Schedule I-24 for Large Commercial Interruptible Service. The terms of this service applicable to firm versus interruptible gas are as follows:

Firm Use Charge

There is an annual charge of $15.60 for each firm use therm per day specified in the contract. The current contract is for 13,500 therms per day which yields an annual charge of $210,600 simply for the privilege of receiving the firm gas. In essence, this purchases an allocation in the pipeline system supplying the natural gas to the local supplier.

Purchased Gas Adjustment (PGA)

This is a specific charge, calculated each month, in accordance with a formula approved by the Public Service Commission, that reflects the actual cost of purchased gas at the supply point. There is a separate PGA for firm gas and interruptible gas. As an example, for the month of June, 1992, the PGA for firm gas was 35.89 cents per therm and the PGA for interruptible gas was 21.30 cents per therm, a premium of 14.59 cents per therm for the purchase of firm gas.

Franchise Recovery Factor

This is basically a fee to the local utility for their recovery of the cost of furnishing gas service to the user. It is a percentage of the sum of the Firm Use Charge and the PGA. This charge does not apply to interruptible gas.

Unauthorized Consumption Of Gas

During times of curtailment, there is a penalty charge of $3.00 per therm for each therm of gas used that exceeds the firm gas commitment.

3.4 Family Housing

The investigation identified 875 family housing units at Fort Gordon. These are located at Boardmans Lake, Gordon Terrace, Maglin Terrace, McNair Terrace and Olive Terrace.

All of these units have natural gas burning furnaces, hot water heaters and ranges. These are all single fuel systems and are not adaptable for dual fuel capability.

3.5 Single Fuel Users

The investigation identified 132 permanent buildings on the fort that have a use for natural gas as the fuel for some equipment. The use in these buildings is typically for heating units, hot water heaters and kitchen equipment. This equipment generally consists of small capacity independent units that use natural gas as a single fuel and is not adaptable to dual fuel capability.

3.6 Central Plants And Other Dual Fuel Users

There are numerous facilities at Fort Gordon that have installed, dual fuel capability, with auxiliary burners for burning fuel oil. Standard procedure is for these facilities to be switched from natural gas firing to fuel oil firing whenever natural gas service is curtailed (interrupted) by the gas company.

These facilities are not included in this LPG Storage Facility Study.

4. DESIGN BASIS

4.1 General

Data from numerous sources was compiled and analyzed to establish a basis for the size and capacity of the propane-air system as well as to determine an optimum level of firm gas commitment. The data was obtained by field investigation of existing facilities, review of recent gas consumption records, gathering data from fort real estate records, through conversations with the operators of propane-air systems, and through information from suppliers of propane and propane-air systems.

4.2 Family Housing Gas Use

During the field investigation of July 14 through July 17, 1992, several representative housing units were inspected the verify the size and type of natural gas users in the units as well as verify the general construction of the units. From this data, total connected load and expected peak load was tabulated. The tabulation is included as Appendix B. From this data it was

established that the total connected load for all family housing units is 128.853 MMBTU/Hr. and the anticipated peak heat load is 70.501 MMBTU/Hr.

4.3 Building Gas Use

Also during the July 14 through July 17, 1992, field investigation, 45 of the 132 other permanent buildings using natural gas as a single fuel were inspected to determine what equipment was actually burning natural gas and what the connected loads were. The permanent buildings not inspected are duplicates of these that were inspected which allowed for a tabulation of the connected load and expected peak load for all of the buildings. The tabulation is included as Appendix C.

The tabulation indicated that the connected load for all of the permanent single fuel natural gas users is 102.712 MMBTU/Hr. with majority of this load being for heating systems. The expected peak load is 29,835 MMBTU/Hr.

This investigation did not include existing buildings that are not permanent and will be demolished.

4.4 Fort Gordon Expansion Plans

Currently identified expansion plans for Fort Gordon include approximately seven new buildings with an estimated square footage of 434,200. While there will be no net gain in total building square footage over the next 10 years due to the demolition of existing WWII buildings, which are currently in use, the new buildings will potentially add to the total permanent natural gas requirements at the fort.

Also included in Appendix C is a tabulation of the potential gas load for the future buildings. Based on the average load per square foot of the existing buildings, the connected load on the gas system for the future buildings could be in the range of 25 MMBTU/Hr.

4.5 Gas Consumption Records

Gas consumption records for the period of July 1988 through June of 1992 were obtained from Atlanta Gas Light Company. Specific information extracted from the records are:

- Gas service has been curtailed for a total of 196 hours through the last four years, an average of 49 hours per year.

- There was only one period where curtailment lasted more than a few hours, that was December 16 and 17, 1989, and December 21 through December 26, 1989. During this time there were 5 full days of curtailment and the average natural gas consumption for these 5 days was 13,000 therms per day, however, consumption was as low as 10,000 therms per day on two of those days. The low consumption, however, may not be representative as these were on the holidays of December 24 and 25, a time when many of the personnel may not have been on the fort.

- Average summer gas consumption for the summer months of June, July and August through the four year period was approximately 8,500 therms per day.

- During the four year period, the average additional cost that Fort Gordon paid for firm gas over interruptible gas was approximately $830,000 per year. This was equivalent to 20.11 cents per therm premium for every therm of firm gas consumed.

- The largest total consumption for the period was December, 1988, where the average daily gas consumption was approximately 27,500 therms per day. There was no curtailment during this month. This peak consumption was matched in January, 1992, during a month where there were 19 hours of natural gas curtailment.

4.6 Defense Fuel Supply Center (DFSC) Contract

The DFSC contract allows the Government an opportunity to purchase natural gas on a spot market basis, generally at a lower cost than natural gas purchased through the utility. The current DFSC contract which is effective for the period July 31, 1991, through January 31, 1993, references the price of natural gas for May of 1991 as an example. This compares to the natural gas purchased from Atlanta Gas Light Company (AGL) as follows:

DFSC price = $.17 per therm (May, 1991)

AGL Interruptible price = $.25 per therm

AGL Firm price = $.50 per therm

4.7 Propane-Air System Information

Pertinent information regarding the capacity and use of the propane-air system was gathered from many sources throughout this study.

- Fort Benning, Georgia operates a propane-air peak shaving system. They mix 25% propane-air with 75% natural gas. The propane-air system is sized to meet the firm gas commitment which is based on summer load and they have a storage capacity of approximately a 15 day supply of propane. The system operates at a pressure of 30 psig. Fort Benning was able to reduce the firm-gas commitment by one-half.

- The City of LaGrange, Georgia, also operates a peak shaving propane-air system. They have mixed as much as 70% propane-air with 30% natural gas in December, 1989, during curtailment. The only problems were complaints of yellow flame and the need to adjust space heaters. Storage system consists of seventeen 30,000 gallon propane tanks. This system operates at 25 psig.

- Propane-air equipment suppliers recommend the propane vaporizer and air mixer be sized to accommodate the total connected load if the system is to be used as an standby plant. This allows adequate gas flow for the condition of all or majority of users burning gas at the same time and is very applicable to Fort Gordon. A large portion of the gas use is in family housing and it is conceivable that at a given time on a cold winter morning, nearly all households would be arising at the same time, and nearly all furnaces, hot water heaters and ranges could be operating simultaneously.. Storage capacity should be sized to accommodate average peak use.

- The propane-air systems require approximately one hour to start-up and bring to full capacity.

- The delivery of liquefied propane is generally accomplished via cross country pipeline and locally by truck. Delivery is usually accomplished within a matter of days after an order is placed, even in winter months when demand is high.

- Delivery of liquefied propane is available by rail, but this is typically more expensive and less available, and does not appear to be practical unless

there is a significantly large, continuous use. Also, additional equipment is required for receipt of propane via rail car.

4.8 Design Basis

Connected Load:	Family Housing	128.9	MMBTU/Hr.
	Permanent Single Fuel Users	102.6	
	Current Total	231.5	MMBTU/Hr.
	Possible Future Expansion	25.1	
	Possible Future Total	256.6	MMBTU/Hr.

Propane-air vaporizer/mixer sized for 230 MMBTU/Hr.

Expected Peak Use:	Current	13,000	therms per day
(During Curtailment)	Future Exp.	100	
	Possible Total	13,100	therms per day

Sized propane storage for 10 days at 13,500 therms (conservative)

5. DESCRIPTION OF PROPOSED NEW FACILITIES

5.1 Overview

To develop the opportunity for Fort Gordon to significantly reduce energy consumption cost, new and modified facilities include:

- New gas pipeline across the fort
- Isolation of existing gas line and distribution system
- Propane-air standby system
- Gas metering modifications

5.2 Natural Gas Pipeline

Since the existing Atlanta Gas Light main through Fort Gordon also services other communities, it is not possible to use the main for propane-air distribution within the fort. Also, since there are 18 different branch mains for local gas distribution within the fort, it is impractical and cost prohibitive to consider adding a propane-air standby system to each of the branch mains. It is, therefore, proposed to install a new gas main through an unpopulated area

of the fort to be used for gas transmission and utilize the existing main for distribution of gas to the users within the fort.

Location Of New Main

It is proposed that the new main tie to the existing main near Gate 5, then cross Avenue of the States and travel along the west side of Avenue of the States to North Range Road. The line would travel westward along North Range Road to 12th Street and then turn northward along 12 Street, 9th Street and 10th Street and again intersect with the existing main near Gate 3. The specific routing of the proposed new line is shown on the maps included in Appendix D.

Ownership Of New Main

Atlanta Gas Light Company is agreeable to accepting ownership of the new main in exchange for passing ownership of the existing main to Fort Gordon under the following stipulations:

- Atlanta Gas Light Company is granted right-of-way easement for the new main comparable to that for the existing main.

- The new pipeline must be built in accordance with Atlanta Gas Light Company specifications, constructed by contractors experienced in pipeline construction for Atlanta Gas Light Company and approved by them, and that all work be done under the direction of Atlanta Gas Light Company.

Alternate Opportunity

Two alternate opportunities were presented by Atlanta Gas Light for consideration in regard to the new pipeline. It appears to be in the best interest of both Fort Gordon and Atlanta Gas Light that the new line actually be installed off of the fort property. The two opportunities presented to accomplish this are as follows:

1) Atlanta Gas Light could build the new pipeline around the east and north perimeter of the fort, starting near Gate 5 and connecting to the existing main near Gate 3. This gives Atlanta Gas Light a potential opportunity to supply new customers in an area that is starting to be developed.

2) Atlanta Gas Light could possibly provide service to Fort Gordon from a new gas main recently installed north of Grovetown.

Both of these alternatives are very preliminary in nature and may or may not be possible, but either could lead to reduced pipeline costs and cost sharing by Atlanta Gas Light. Fort Gordon should pursue them both to see what arrangements can be made with Atlanta Gas Light.

5.3 Propane-Air System

It is proposed that a propane-air storage and supply system be constructed at the old coal storage site near Chamberlin Avenue and 10th Street.

System Description

The propane-air system will consist of a series of 30,000 gallon propane storage tanks, LPG pumps, a waterbath vaporizer, mixer, air compressor, air receiver, a test flare, and a truck unloading station.

There are 6 proposed 30,000 gallon propane storage tanks. The tanks may be filled to 85% with liquid propane per NFPA #58. The capacity of the tanks is equivalent to 14,000 therms per day for 10 days. This covers the current expected use as well as allowing for 1,000 therms per day growth at the fort. NFPA #58 regulations limit storage capacity in any one area to 180,000 gallons. A water spray fire protection system will be included for each tank.

Propane is delivered and stored in a liquid state. Prior to injection into the gas line as a fuel it must first be vaporized. Propane vapor also has a much higher heating value than natural gas so it also must be mixed (diluted) with air to create a fuel with characteristics matching those of natural gas. To accomplish this the system must include a vaporizer, air compressor and mixer.

A test flare is also required as part of the propane-air system for safety during start-up and for checking characteristics of the propane-air mixture prior to releasing the fuel into the distribution system.

System Operation

The propane-air system proposed will deliver a mixture of approximately 55% propane and 45% air at a pressure of 75 psi. It would deliver a quantity of propane-air up to a capacity of 230 MMBTU/Hr. to accommodate the maximum current demand that could be expected at any one time. It will have a control system that will monitor the characteristics of the fuel and the usage so that once the system is started it will continue to run while unattended. A schematic of the system is included in Appendix E for reference.

The operating pressure of 75 psi was selected for two reasons. First, this pressure, based on analysis of the existing 8" main and branches will provide sufficient pressure for operating the entire distribution system now and in the future. Secondly, this pressure would also potentially allow Fort Gordon to use propane-air as the back-up for some of the dual fuel users should that become a necessity.

Space Requirements

NFPA #58 regulations require propane tankage to be separated as described previously and requires other components such as the vaporizer/mixer equipment, truck unloading, and the test flare to be separated. Likewise, separation must be maintained between the propane-air system and other facilities.

Allowing space for the potential future addition of two tank storage areas at 6 tanks each, an area of approximately 334 feet by 570 feet must be dedicated for the propane-air system. A potential layout of the area is included in Appendix E.

5.4 Natural Gas Metering

Atlanta Gas Light has recommended that the metering station at Gate 3 be used for the modified service to the fort. There are two turbine meters used at this installation and these are the newest of the meters on the fort. These meters are owned by Atlanta Gas Light and would be used for future gas

metering and billing. The existing meters at Gate 5 would be removed as they would no longer be required.

In the past, Fort Gordon has experienced metering errors related to the gas consumption and there is concern that the reliability of the turbine meters may be less than accurate over the wide range of gas use rates experienced between the various seasons. It is, therefore, proposed that Fort Gordon also install an auxiliary gas meter to check the gas company meters.

A mass flow measurement meter that operates on the principal of thermal dispersion detection is proposed. This type meter inserts into the gas line, has no moving parts, and measures mass flow directly, eliminating the need for pressure or temperature compensation. The meter has a high turn down ratio which means it can accurately measure very low flows as well as very high flows. This meter also provides for remote reading as well as local recording so it can be connected to the fort's EMCS (energy management and control system).

A typical vendors catalog data is included in Appendix J. for reference.

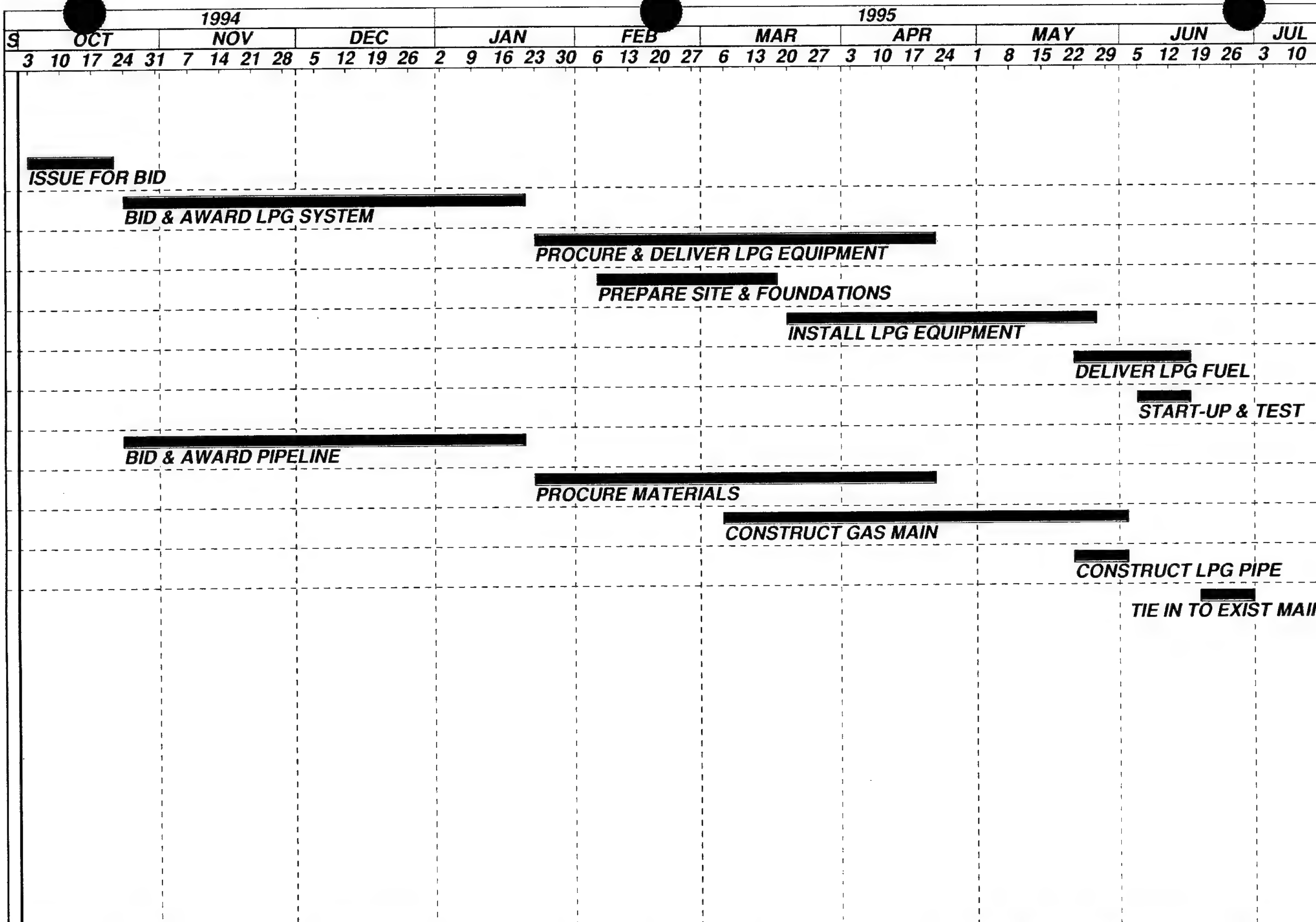
5.5 Gas Distribution System

Upon installation of the new gas main across or around the fort, the existing gas main going through the fort would become a distribution main within the fort only.

The main is proposed to operate at a pressure of 75 psi, one-fourth the current 300 psi operating pressure. At the 75 psi operating pressure, flow and pressure to the branch mains will provide adequate gas supply to all the current users. Furthermore, this pressure would appear to be adequate to supply propane-air to the central plants and other dual fired users to allow the fort an opportunity to select between propane-air or fuel-oil for backup during curtailment.

6. PROJECT SCHEDULE

Following is a milestone schedule for construction of the propane-air standby system for Fort Gordon. Based on current availability of materials and equipment, it appears that the propane-air system and new pipeline could be bid, and constructed in approximately nine months.



Plot Date	8SEP92
Data Date	1OCT94
Project Start	1OCT94
Project Finish	30JUN95

(c) Primavera Systems, Inc.

Activity Bar/Early Dates
Critical Activity
Progress Bar
Milestone/Flag Activity

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Sheet 1 of 1

FORT GORDON, GEORGIA - PROJ 7469B
LPG STORAGE FACILITY STUDY
PRELIMINARY MILESTONE SCHEDULE

SIMONS-EASTERN CONSULTANTS, INC. - ATLANTA, GA

Date	Revision	Checked	Approved

7469

7. CAPITAL COST ESTIMATE

7.1 Summary

The estimated construction cost for all aspects of the standby propane-air system for Fort Gordon are summarized as follows:

1.	Propane-Air System	$1,296,776
2.	Relocated Pipeline	1,128,875
3.	Auxiliary Meter	21,582
	Total Construction Cost	$2,447,233

This summary includes construction cost for materials, equipment and installation only and is based on August, 1992, prices escalated to mid-point FY95. Engineering, SIOH, and contingency are included on DD Form 1391.

7.2 Third Party Ownership

The possibility of third party ownership of the propane-air system was reviewed with various vendors.

Typically, the vendors do not have the financial capability and are not in the business to own propane-air systems, especially systems of the size required for Fort Gordon. Additionally, the vendors would not consider third party ownership unless propane is the primary fuel and the user would guarantee a level of usage.

Third party ownership would limit Fort Gordon to one source of supply. The supplier would control cost and delivery, and would eliminate any possibility of competitive pricing. This would appear to create a worse situation than Fort Gordon is currently in with the gas company.

7.3 DD Form 1391

A preliminary DD Form 1391 has been prepared and is included following this page.

1. COMPONENT ARMY	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 8 SEP 92

3. INSTALLATION AND LOCATION	4. PROJECT TITLE
FORT GORDON, GEORGIA	LPG STORAGE FACILITY, ECIP, FACILITY ENERGY IMPROVEMENTS

5. PROGRAM ELEMENT	6. CATEGORY CODE	7. PROJECT NUMBER	8. PROJECT COST ($000)
	80000		$2,950

9. COST ESTIMATES

ITEM	U/M	QUANTITY	UNIT COST	COST ($000)
PRIMARY FACILITY				1,300
Propane Air Standby System	LS	-	-	(1,300)
SUPPORTING FACILITY				1,150
Gas Distribution Main Relocation	LS	-	-	(1,130)
Auxiliary Gas Meter	LS	-	-	(20)
SUBTOTAL				2,450
CONTINGENCY (7.5%)				200
DESIGN COST (6%)				150
SUPERVISION INSP & OVERHEAD (6%)				150
TOTAL REQUEST				2,950

10. DESCRIPTION OF PROPOSED CONSTRUCTION

The primary facility is a permanent propane-air standby facility consisting of a propane vaporizer/mixer capable of delivering 230 million BTU/hr of a propane-air mixture at 75 psig. The propane-air mixture is to be injected into an existing natural gas distribution pipe to use the propane-air as back-up fuel for times of natural gas curtailments. The facility will include six 30,000 gallon propane storage tanks with the capacity to store approximately a 10 day supply of fuel for back-up service. The installation of the system will require relocation of the existing gas main, owned by the public utility, to allow isolation of the on fort distribution system to enable the fort to use the propane-air fuel supply. Auxiliary gas metering is to be installed to allow for verification of natural gas use as shown on monthly billings.

This is a new facility that will require no demolition or asbestos abatement. Accessibility for the handicapped is not required for functional and safety reasons.

1. COMPONENT ARMY	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 8 SEP 92

3. INSTALLATION AND LOCATION

FORT GORDON, GEORGIA

4. PROJECT TITLE LPG STORAGE FACILITY, ECIP	6. PROJECT NUMBER

11. REQUIREMENT: None ADEQUATE: None SUBSTD: None

PROJECT:
Construct propane-air standby facility including propane storage and relocation of existing natural gas main.

The project is required to allow isolation of the fort from the public utility and to allow the use of propane-air as a back-up fuel for natural gas during times of curtailment. This is needed to reduce the financial commitment to the public utility to guarantee a minimum level of natural gas supply during curtailment.

CURRENT SITUATION:
Natural gas is furnished by a public utility via the utility owned main through the fort. There are numerous natural gas users, such as family housing, that will require gas at all times without curtailment in times of high consumption or shortages. Guaranteed delivery of gas demands a premium cost that currently is approximately $830,000 annually. There is no economical opportunity available for reduction of this cost or use of a standby fuel as there is no existing way to isolate Fort Gordon from the public utility.

IMPACT IF NOT PROVIDED:
Failure to approve this project will result in a continued annual cost to be paid to the public utility to assure a minimum level of natural gas supply at all times to support family housing and other natural gas users.

ADDITIONAL:
This project has been coordinated with the installation physical security plan, and no security improvements are required. This project complies with the scope and design criteria of DOD 4270.1M "Construction Criteria" that were in effect 1 January 1987, as implemented by the Army's Architectural and Engineering Instruction (AEI), "Design Criteria", dated 14 July 1989. An economic analysis has been prepared for this project in accordance with Energy Conservation Investment Program (ECIP) guidance. The analysis indicates a savings to investment ratio of 5.18 with a payback of investment in 3.36 years. Auxiliary gas metering will be installed to verify natural gas use and savings.

1. COMPONENT ARMY	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 8 SEP 92

3. INSTALLATION AND LOCATION FORT GORDON, GEORGIA	
4. PROJECT TITLE LPG STORAGE FACILITY, ECIP	6. PROJECT NUMBER

SECTION 7 - GENERAL

This ECIP project is required to support the Army wide effort to reduce energy cost. The project will provide a new propane-air standby system to deliver an alternate fuel at times when natural gas service from the public utility is curtailed. The backup system will allow purchase of all natural gas from the public utility at a much lower rate for interruptible service plus allow for purchase of natural gas via the Defense Fuel Supply Center (DFSC) contracts.

This project has been coordinated with the installation physical security plan and no security improvements are required.

SECTION 8 - PRESENT ACCOMMODATION & DISPOSITION

This project installs new propane -air storage and delivery equipment to support current assets. No present assets will be disposed of in this project.

SECTION 9 - REAL PROPERTY MAINTENANCE

The propane-air standby system will require approximately 190,000 square feet of land area utilizing currently unused area that was previously a cool storage area.

SECTION 10 - ANALYSIS OF DEFICIENCIES

There is no current fuel alternate for family housing and other single fuel (natural gas) users. With no backup, Fort Gordon must purchase natural gas at a premium rate for guaranteed delivery of natural gas. This premium rate cost is in excess of $800,000 per year.

SECTION 11 - ECONOMIC ANALYSIS

Economic analysis of this project was prepared utilizing Life Cycle Cost In Design (LCCID). The savings to investment ration (SIR) for this project is 5.18 and the simple payback period is 3.36 years.

1. COMPONENT ARMY	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 8 SEP 92

3. INSTALLATION AND LOCATION

FORT GORDON, GEORGIA

4. PROJECT TITLE LPG STORAGE FACILITY, ECIP	6. PROJECT NUMBER

SECTION 12 - CRITERIA FOR PROPOSED CONSTRUCTION

Construction will conform to existing guidelines of architectural design and building construction, specifically the AEI Design Guide (March, 1987) and Corps of Engineers Guide Specs. A Project Development Brochure (PDB) will be prepared for the project.

SECTION 13 - FURNISHINGS AND EQUIPMENT

There are no related furnishings and equipment involved in this project.

SECTION 14 - SURVIVAL MEASURE

There are no survival measures required by this project.

SECTION 15 - ENVIRONMENTAL ANALYSIS

We have reviewed this project and determined that an environmental impact statement, pursuant to PL 91-190, is not required. We have assessed this project and determined that it will not contribute significantly to air and/or water pollution.

SECTION 16 - EVALUATION OF FLOOD HAZARD

These facilities are not sited within areas known to be subject to flooding and do not encroach on wetlands.

SECTION 17 - INFORMATION SYSTEMS SUPPORT

This project does not include information system or telecommunication costs.

SECTION F18 - HISTORIC AND ARCHEOLOGICAL SITES

We have reviewed this project and determined that there is no impact on any historic or archeological sites.

1. COMPONENT ARMY	FY 1995 MILITARY CONSTRUCTION PROJECT DATA	2. DATE 8 SEP 92

3. INSTALLATION AND LOCATION
FORT GORDON, GEORGIA

4. PROJECT TITLE	6. PROJECT NUMBER
LPG STORAGE FACILITY, ECIP	

SECTION 19 - ENERGY AND UTILITY REQUIREMENTS

This project will provide a new propane-air backup system to deliver a capacity of 230 million BTU per hour as an alternate to natural gas. The facility will include adequate propane storage to provide a backup fuel source for 10 days of use by family housing and other single fuel users. The availability of a backup fuel for natural gas will allow for purchase of natural gas from the public utility at a lower rate resulting in an estimated annual saving of $830,000.

SECTION 20 - PROVISIONS FOR THE HANDICAPPED

In accordance with Public Law 90-480, no provision for the handicapped will be made in the project since, in the foreseeable future, the facility will be used and operated solely by able bodied personnel.

SECTION 21 - COMMERCIAL ACTIVITIES

Project is not considered for commercial activity.

SECTION 22 - PHYSICAL SECURITY

This project has been coordinated with the installation security plan and no security improvements are required.

8. LIFE CYCLE COST ANALYSIS

8.1 Cost Reduction Opportunities

Life cycle cost analyses were prepared for several different energy cost reduction opportunities as described below. The Life Cycle Cost In Design (LCCID) program was used for the analyses. It is important to note the analyses were based on energy cost reduction, not energy use reduction.

The opportunities evaluated consisted of:

1) Reduce firm gas commitment to 10,000 therms per day, the lowest consumption level achieved while on curtailment, and face potential penalties.

2) Reduce firm gas commitment to 8,500 therms per day, the average summer consumption level, and face potential penalties.

3) Reduce firm gas commitment to 0, face harsh penalty charges in case of curtailment. (This option would probably not be accepted by the natural gas supplier).

4) Reduce firm gas commitment to 10,000 therms per day and install LPG peak shaving system.

5) Reduce firm gas commitment to 8,500 therms per day and install LPG peak shaving system.

6a) Reduce firm gas commitment to 0 and install LPG standby system.

6b) Reduce firm gas commitment to 0 and install LPG standby system without relocating existing natural gas pipeline.

8.2 Results

Options 1, 2 and 3 all yield significant potential savings to the fort and require no capital outlay. The only risk is the potential financial penalties that would

be imposed if natural gas was curtailed for more than the 2 day per year average experience over the last 4 years.

Options 4 and 5, reduction of firm gas commitment with installation of LPG peak shaving also offer significant potential savings. They meet Energy Conservation Investment Program (ECIP) requirements of having an savings to investment ratio (SIR) of greater than 1 and a simple payback period of less than 8 years. These options, however, offer no significant difference in savings over options 1 and 2, based on the average curtailment of 2 days per year.

Option 6a and 6b, elimination of firm gas commitment and installation of an LPG standby system offers the greatest life cycle cost savings, with the greatest SIR and lowest payback period. This supports the initial direction given for preparation of this study.

The LCCID summary sheets for each opportunity analyzed are included following this page. Additional summary sheets analyzing greater than average curtailment periods are included for reference with the calculations in Appendix G.

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: Fort Gordon REGION NO: 4 PROJECT NUMBER: 7469B
PROJECT TITLE: LPG Study FISCAL YEAR: 95
DISCRETE PORTION NAME: Firm = 10,000, 2 day
ANALYSIS DATE: 9/2/92 ECONOMIC LIFE: 20 yrs. PREPARER: G. W. Smith

1. INVESTMENT

A.	CONSTRUCTION COST (+ contingency)	$ 0
B.	SIOH (6%)	$ 0
C.	DESIGN COST (6%)	$ 0
D.	TOTAL COST (1A+1B+1C)	$ 0
E.	SALVAGE VALUE OF EXISTING EQUIPMENT	$ 0
F.	PUBLIC UTILITY COMPANY REBATE	$ 0
G.	TOTAL INVESTMENT (1D-1E-1F)	$ 0

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS: _____

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$		$		$
B. DIST	$		$		$
C. RESID	$		$		$
D. NG	$		$		$
E. PPG	$		$		$
F. COAL	$		$		$
G. SOLAR	$		$		$
H. GEOTH	$		$		$
I. BIOMA	$		$		$
J. REFUS	$		$		$
K. WIND	$		$		$
L. OTHER	$		$		$
M. DEMAND SAVINGS			$215,185	17.25	$3,711,925
N. TOTAL			$215,185		$3,711,925

3. NONENERGY SAVINGS(+) OR COST (-):

A. ANNUAL RECURRING (+/-): $(-) 21,000
(1) DISCOUNT FACTOR (TABLE A-2): 12.90
(2) DISCOUNTED SAVING/COST (3A X 3A1): $(-) 270,900

B. NONRECURRING SAVINGS (+) OR COST (-)

ITEM SAVINGS(+) COST (-)(1)	YEAR OF OCCURRENCE(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAVINGS(+) COST (-)(4)
(1) $			$
(2) $			$
(3) $			$
(4) TOTAL	$	$	

C. TOTAL NONENERGY DISCOUNTED SAVINGS (3A2+3B4d): $(-)270,900

4. SIMPLE PAYBACK 1G/[2N(3)+3A+(3Bd(4)/Econ Life)]: N/A YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $3,441,025

6. SAVINGS TO INVESTMENT RATIO (SIR) (5/1G): N/A

SIMONS

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: Fort Gordon REGION NO: 4 PROJECT NUMBER: 7469B
PROJECT TITLE: LPG Study FISCAL YEAR: 95
DISCRETE PORTION NAME: Firm = 8,500, 2 day
ANALYSIS DATE: 9/2/92 ECONOMIC LIFE: 20 yrs. PREPARER: G. W. Smith

1. INVESTMENT

A.	CONSTRUCTION COST (+ contingency)	$	0
B.	SIOH (6%)	$	0
C.	DESIGN COST (6%)	$	0
D.	TOTAL COST (1A+1B+1C)	$	0
E.	SALVAGE VALUE OF EXISTING EQUIPMENT	$	0
F.	PUBLIC UTILITY COMPANY REBATE	$	0
G.	TOTAL INVESTMENT (1D-1E-1F)	$	0

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS: _____

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$		$		$
B. DIST	$		$		$
C. RESID	$		$		$
D. NG	$		$		$
E. PPG	$		$		$
F. COAL	$		$		$
G. SOLAR	$		$		$
H. GEOTH	$		$		$
I. BIOMA	$		$		$
J. REFUS	$		$		$
K. WIND	$		$		$
L. OTHER	$		$		$
M. DEMAND SAVINGS			$307,407	17.25	$5,302,804
N. TOTAL			$307,407		$5,302,804

3. NONENERGY SAVINGS(+) OR COST (-):

A. ANNUAL RECURRING (+/-): $(-)30,000
(1) DISCOUNT FACTOR (TABLE A-2): 12.90
(2) DISCOUNTED SAVING/COST (3A X 3A1): $(-)387,000

B. NONRECURRING SAVINGS (+) OR COST (-)

	ITEM SAVINGS(+) COST (-)(1)	YEAR OF OCCURRENCE(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAVINGS(+) COST (-)(4)
(1)	$			$
(2)	$			$
(3)	$			$
(4)	TOTAL		$	$

C. TOTAL NONENERGY DISCOUNTED SAVINGS (3A2+3B4d): $(-)387,000

4. SIMPLE PAYBACK 1G/[2N(3)+3A+(3Bd(4)/Econ Life)]: N/A YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $4,915,804

6. SAVINGS TO INVESTMENT RATIO (SIR) (5/1G): N/A

SIMONS

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: Fort Gordon REGION NO: 4 PROJECT NUMBER: 7469B
PROJECT TITLE: LPG Study FISCAL YEAR: 95
DISCRETE PORTION NAME: Peak, Firm = 10,000
ANALYSIS DATE: 9/2/92 ECONOMIC LIFE: 20 yrs. PREPARER: G. W. Smith

1. INVESTMENT

A.	CONSTRUCTION COST (+ contingency)	$ 1,945,716
B.	SIOH (6%)	$ 116,743
C.	DESIGN COST (6%)	$ 116,743
D.	TOTAL COST (1A+1B+1C)	$ 2,179,202
E.	SALVAGE VALUE OF EXISTING EQUIPMENT	$ 0
F.	PUBLIC UTILITY COMPANY REBATE	$ 0
G.	TOTAL INVESTMENT (1D-1E-1F)	$ 2,179,202

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS: _____

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$		$		$
B. DIST	$		$		$
C. RESID	$		$		$
D. NG	$		$		$
E. PPG	$		$		$
F. COAL	$		$		$
G. SOLAR	$		$		$
H. GEOTH	$		$		$
I. BIOMA	$		$		$
J. REFUS	$		$		$
K. WIND	$		$		$
L. OTHER	$		$		$
M. DEMAND SAVINGS			$215,185	17.25	$3,711,925
N. TOTAL			$215,185		$3,711,925

3. NONENERGY SAVINGS(+) OR COST (-):

A. ANNUAL RECURRING (+/-): $(-) 14,100
(1) DISCOUNT FACTOR (TABLE A-2): 12.90
(2) DISCOUNTED SAVING/COST (3A X 3A1): $(-)181,890

B. NONRECURRING SAVINGS (+) OR COST (-)

ITEM SAVINGS(+) COST (-)(1)	YEAR OF OCCURRENCE(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAVINGS(+) COST (-)(4)
(1) $			$
(2) $			$
(3) $			$
(4) TOTAL		$	$

C. TOTAL NONENERGY DISCOUNTED SAVINGS (3A2+3B4d): $(-)181,890

4. SIMPLE PAYBACK 1G/[2N(3)+3A+(3Bd(4)/Econ Life)]: 10.84 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $3,530,035

6. SAVINGS TO INVESTMENT RATIO (SIR) (5/1G): 1.62

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: Fort Gordon REGION NO: 4 PROJECT NUMBER: 7469B
PROJECT TITLE: LPG Study FISCAL YEAR: 95
DISCRETE PORTION NAME: Peak, Firm = 8,500
ANALYSIS DATE: 9/2/92 ECONOMIC LIFE: 20 yrs. PREPARER: G. W. Smith

1. INVESTMENT

A.	CONSTRUCTION COST (+ contingency)	$	2,029,882
B.	SIOH (6%)	$	121,793
C.	DESIGN COST (6%)	$	121,793
D.	TOTAL COST (1A+1B+1C)	$	2,273,468
E.	SALVAGE VALUE OF EXISTING EQUIPMENT	$	0
F.	PUBLIC UTILITY COMPANY REBATE	$	0
G.	TOTAL INVESTMENT (1D-1E-1F)	$	2,273,468

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS: _____

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$		$		$
B. DIST	$		$		$
C. RESID	$		$		$
D. NG	$		$		$
E. PPG	$		$		$
F. COAL	$		$		$
G. SOLAR	$		$		$
H. GEOTH	$		$		$
I. BIOMA	$		$		$
J. REFUS	$		$		$
K. WIND	$		$		$
L. OTHER	$		$		$
M. DEMAND SAVINGS			$307,407	17.25	$5,302,804
N. TOTAL			$307,407		$5,302,804

3. NONENERGY SAVINGS(+) OR COST (-):

A. ANNUAL RECURRING (+/-): $(-)15,900
(1) DISCOUNT FACTOR (TABLE A-2): 12.90
(2) DISCOUNTED SAVING/COST (3A X 3A1): $(-)205,110

B. NONRECURRING SAVINGS (+) OR COST (-)

ITEM SAVINGS(+) COST (-)(1)	YEAR OF OCCURRENCE(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAVINGS(+) COST (-)(4)
(1) $			$
(2) $			$
(3) $			$
(4) TOTAL		$	$

C. TOTAL NONENERGY DISCOUNTED SAVINGS (3A2+3B4d): $(-)205,110

4. SIMPLE PAYBACK 1G/[2N(3)+3A+(3Bd(4)/Econ Life)]: 7.80 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $5,097,694

6. SAVINGS TO INVESTMENT RATIO (SIR) (5/1G): 2.24

SIMONS

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: Fort Gordon REGION NO: 4 PROJECT NUMBER: 7469B
PROJECT TITLE: LPG Study FISCAL YEAR: 95
DISCRETE PORTION NAME: 100% Standby
ANALYSIS DATE: 9/2/92 ECONOMIC LIFE: 20 yrs. PREPARER: G. W. Smith

1. INVESTMENT

A.	CONSTRUCTION COST (+ contingency)	$ 2,413,556
B.	SIOH (6%)	$ 144,813
C.	DESIGN COST (6%)	$ 144,813
D.	TOTAL COST (1A+1B+1C)	$ 2,703,182
E.	SALVAGE VALUE OF EXISTING EQUIPMENT	$ 0
F.	PUBLIC UTILITY COMPANY REBATE	$ 0
G.	TOTAL INVESTMENT (1D-1E-1F)	$ 2,703,182

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS: ____

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$		$		$
B. DIST	$		$		$
C. RESID	$		$		$
D. NG	$		$		$
E. PPG	$		$		$
F. COAL	$		$		$
G. SOLAR	$		$		$
H. GEOTH	$		$		$
I. BIOMA	$		$		$
J. REFUS	$		$		$
K. WIND	$		$		$
L. OTHER	$		$		$
M. DEMAND SAVINGS			$830,000	17.25	$14,317,530
N. TOTAL			$830,000		$14,317,530

3. NONENERGY SAVINGS(+) OR COST (-):

A. ANNUAL RECURRING (+/-): $(-)25,050
(1) DISCOUNT FACTOR (TABLE A-2): 12.90
(2) DISCOUNTED SAVING/COST (3A X 3A1): $(-)323,145

B. NONRECURRING SAVINGS (+) OR COST (-)

ITEM SAVINGS(+) COST (-)(1)	YEAR OF OCCURRENCE(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAVINGS(+) COST (-)(4)
(1) $			$
(2) $			$
(3) $			$
(4) TOTAL		$	$

C. TOTAL NONENERGY DISCOUNTED SAVINGS (3A2+3B4d): $(-)323,145

4. SIMPLE PAYBACK 1G/[2N(3)+3A+(3Bd(4)/Econ Life)]: 3.36 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $13,994,390

6. SAVINGS TO INVESTMENT RATIO (SIR) (5/1G): 5.18

SIMONS

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: Fort Gordon REGION NO: 4 PROJECT NUMBER: 7469B
PROJECT TITLE: LPG Study FISCAL YEAR: 95
DISCRETE PORTION NAME: 100% Standby w/o Pipeline
ANALYSIS DATE: 9/2/92 ECONOMIC LIFE: 20 yrs. PREPARER: G. W. Smith

1. INVESTMENT

A.	CONSTRUCTION COST (+ contingency)	$ 1,300,216
B.	SIOH (6%)	$ 78,013
C.	DESIGN COST (6%)	$ 78,013
D.	TOTAL COST (1A+1B+1C)	$ 1,456,242
E.	SALVAGE VALUE OF EXISTING EQUIPMENT	$ 0
F.	PUBLIC UTILITY COMPANY REBATE	$ 0
G.	TOTAL INVESTMENT (1D-1E-1F)	$ 1,456,242

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS: _____

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$		$		$
B. DIST	$		$		$
C. RESID	$		$		$
D. NG	$		$		$
E. PPG	$		$		$
F. COAL	$		$		$
G. SOLAR	$		$		$
H. GEOTH	$		$		$
I. BIOMA	$		$		$
J. REFUS	$		$		$
K. WIND	$		$		$
L. OTHER	$		$		$
M. DEMAND SAVINGS			$830,000	17.25	$14,317,530
N. TOTAL			$830,000		$14,317,530

3. NONENERGY SAVINGS(+) OR COST (-):

A. ANNUAL RECURRING (+/-): $(-)25,050
(1) DISCOUNT FACTOR (TABLE A-2): 12.90
(2) DISCOUNTED SAVING/COST (3A X 3A1): $(-)323,145

B. NONRECURRING SAVINGS (+) OR COST (-)

ITEM SAVINGS(+) COST (-)(1)	YEAR OF OCCURRENCE(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAVINGS(+) COST (-)(4)
(1) $			$
(2) $			$
(3) $			$
(4) TOTAL	$	$	

C. TOTAL NONENERGY DISCOUNTED SAVINGS (3A2+3B4d): $(-)323,145

4. SIMPLE PAYBACK 1G/[2N(3)+3A+(3Bd(4)/Econ Life)]: 1.81 YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $13,994,390

6. SAVINGS TO INVESTMENT RATIO (SIR) (5/1G): 9.61

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: Fort Gordon REGION NO: 4 PROJECT NUMBER: 7469B
PROJECT TITLE: LPG Study FISCAL YEAR: 95
DISCRETE PORTION NAME: Firm = 0, No Standby
ANALYSIS DATE: 9/2/92 ECONOMIC LIFE: 20 yrs. PREPARER: G. W. Smith

1. INVESTMENT

A.	CONSTRUCTION COST (+ contingency)	$	0
B.	SIOH (6%)	$	0
C.	DESIGN COST (6%)	$	0
D.	TOTAL COST (1A+1B+1C)	$	0
E.	SALVAGE VALUE OF EXISTING EQUIPMENT	$	0
F.	PUBLIC UTILITY COMPANY REBATE	$	0
G.	TOTAL INVESTMENT (1D-1E-1F)	$	0

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS: _____

ENERGY SOURCE	COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	$		$		$
B. DIST	$		$		$
C. RESID	$		$		$
D. NG	$		$		$
E. PPG	$		$		$
F. COAL	$		$		$
G. SOLAR	$		$		$
H. GEOTH	$		$		$
I. BIOMA	$		$		$
J. REFUS	$		$		$
K. WIND	$		$		$
L. OTHER	$		$		$
M. DEMAND SAVINGS			$830,000	17.25	$14,317,530
N. TOTAL			$830,000		$14,317,530

3. NONENERGY SAVINGS(+) OR COST (-):

A.	ANNUAL RECURRING (+/-):	$(-)81,000
	(1) DISCOUNT FACTOR (TABLE A-2):	12.90
	(2) DISCOUNTED SAVING/COST (3A X 3A1):	$(-)1,044,900

B. NONRECURRING SAVINGS (+) OR COST (-)

	ITEM SAVINGS(+) COST (-)(1)	YEAR OF OCCURRENCE(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAVINGS(+) COST (-)(4)
(1)	$			$
(2)	$			$
(3)	$			$
(4)	TOTAL		$	$

C. TOTAL NONENERGY DISCOUNTED SAVINGS (3A2+3B4d): $(-)1,044,900

4. SIMPLE PAYBACK 1G/[2N(3)+3A+(3Bd(4)/Econ Life)]: N/A YEARS

5. TOTAL NET DISCOUNTED SAVINGS (2N5+3C): $13,272,630

6. SAVINGS TO INVESTMENT RATIO (SIR) (5/1G): N/A

9. CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions

The most attractive economic option to Fort Gordon is to totally eliminate the firm gas commitment to Atlanta Gas Light Company and install an LPG (propane-air) standby system to provide fuel during periods of natural gas curtailments.

9.2 Recommendations

There are three recommendations to be made as a result of this study.

1) Relocate the gas main through the fort so the existing main and branches can become a local distribution header that can be isolated when necessary from the Atlanta Gas Light System. Install a full capacity propane-air standby system to supply fuel to the single fuel users during periods of natural gas curtailments.

2) Recommendation 1 can apparently not be implemented until at least FY95. It is also recommended, therefore, that reduction of the firm gas commitment to 10,000 therms per day or 8,500 therms per day described as cost reduction opportunities 1 and 2 be negotiated with Atlanta Gas Light Company as an interim step. This would present Fort Gordon with significant annual cost savings until such time as the new pipeline and standby propane-air system can be funded and constructed.

3) It became apparent during this study that there would be significant benefit to Atlanta Gas Light Company and benefit to Fort Gordon, if the pipeline were to be relocated to a location outside of the fort. Fort Gordon should pursue this further with Atlanta Gas Light Company with the assumption that the gas company could absorb a major portion of the pipeline cost due to the benefit they would receive.

Appendix A - Glossary Of Terms

BTU	British Thermal Unit
cathodic protection	system to electrically protect burial pipe from corrosion
connected load	the total nameplate rating for gas using equipment
dual fuel	refers to equipment with the capabilities to burn two completely different fuels, i.e., natural gas and fuel oil
ECIP	Energy Conservation Investment Program
firm gas	quantity of natural gas purchase that cannot be interrupted during curtailment
heating value	a quantity in BTU that defines amount of heat available in a specified quantity of fuel

interruptible gas	natural gas supply that can be discontinued by the natural gas supplier during periods of curtailment due to high usage or shortages
LCCID	Life Cycle Cost In Design - computer program specifically for analysis of ECIP projects
LPG	liquefied petroleum gas
MMBTU/Hr.	million british thermal units per hour
MCF	thousand cubic feet
NFPA #58	National Fire Protection Association, Code Number 58
psi	pound per square inch
peak shaving system	fuel system designed to keep the purchased fuel at a constant level and provide back-up fuel for upward swings or peaks in fuel use

propane-air	mixture of propane gas and air to produce a mixture with a lower heating value than pure propane
propane	one form of petroleum gas
right of way easement	legal grant to another entity for the unhindered use of a portion of your land
SIR	savings to investment ratio
SIOH	supervision, inspection, overhead
therm	measurement quantity equivalent to 100,000 btu's

NATURAL GAS LOADS - FAMILY HOUSING
FORT GORDON, GEORGIA

BUILDING NUMBER	QUARTER TYPE	NO. OF DU	STORIES	BR	AREA (SF)	DWG NO	CONNECTED LOAD (1000 BTUH) FURNACE	CONNECTED LOAD (1000 BTUH) HW HEAT	CONNECTED LOAD (1000 BTUH) RANGE	EXPECTED PEAK LOAD (1000 BTUH) FURNACE	EXPECTED PEAK LOAD (1000 BTUH) HW HEAT	EXPECTED PEAK LOAD (1000 BTUH) RANGE
8	3 BR COL	1	1	3	1806	A-9	82	40	25	70	32	6
10	3 BR COL	1	1	3	1806	A-9	82	40	25	70	32	6
11	3 BR COL	1	1	3	1806	A-9	82	40	25	70	32	6
12	3 BR COL	1	1	3	1806	A-9	82	40	25	70	32	6
13	3 BR COL	1	1	3	1806	A-9	82	40	25	70	32	6
14	3 BR COL	1	1	3	1806	A-9	82	40	25	70	32	6
15	3 BR COL	1	1	3	1806	A-9	82	40	25	70	32	6
16	3 BR COL	1	1	3	1806	A-9	82	40	25	70	32	6
17	3 BR COL	1	1	3	1806	A-9	82	40	25	70	32	6
18	3 BR COL	1	1	3	1806	A-9	82	40	25	70	32	6
19	3 BR COL	1	1	3	1806	A-9	82	40	25	70	32	6
20	3 BR COL	1	1	3	1806	A-9	82	40	25	70	32	6
21	3 BR COL	1	1	3	1806	A-9	82	40	25	70	32	6
22	3 BR COL	1	1	3	1806	A-9	82	40	25	70	32	6
23	3 BR COL	1	1	3	1806	A-9	82	40	25	70	32	6
25	3 BR COL	1	1	3	1806	A-9	82	40	25	70	32	6
26	3 BR COL	1	1	3	1806	A-9	82	40	25	70	32	6
27	3 BR COL	1	1	3	1806	A-9	82	40	25	70	32	6
30	3 BR COL	1	1	3	1806	A-9	82	40	25	70	32	6
9	4 BR COL	1	1	4	2033	A-10	82	40	25	70	32	6
24	4 BR COL	1	1	4	2033	A-10	82	40	25	70	32	6
28	4 BR COL	1	1	4	2033	A-10	82	40	25	70	32	6
29	4 BR COL	1	1	4	2033	A-10	82	40	25	70	32	6
31	IVSO4	1	1	4	2033	A-32	82	40	25	70	32	6
32	IVSO4	1	1	4	2033	A-32	82	40	25	70	32	6
33	IVSO4	1	1	4	2033	A-32	82	40	25	70	32	6
34	IVSO4	1	1	4	2033	A-32	82	40	25	70	32	6
1	GENERAL	1	1	4	2033		100	60	25	70	48	6
2	GENERAL	1	1	4	2033		100	60	25	70	48	6
3	GENERAL	1	1	4	2033		100	60	25	70	48	6
4	GENERAL	1	1	4	2033		100	60	25	70	48	6
5	GENERAL	1	1	4	2033		100	60	25	70	48	6
6	GENERAL	1	1	4	2033		100	60	25	70	48	6
751	IVFG01	1	2	3	1640	A-11	82	40	25	70	32	6
753	IVFG01	1	2	3	1640	A-11	82	40	25	70	32	6

NATURAL GAS LOADS - FAMILY HOUSING
FORT GORDON, GEORGIA

							CONNECTED LOAD (1000 BTUH)			EXPECTED PEAK LOAD (1000 BTUH)		
BUILDING NUMBER	QUARTER TYPE	NO. OF DU	STORIES	BR	AREA (SF)	DWG NO	FURNACE	HW HEAT	RANGE	FURNACE	HW HEAT	RANGE
766	CG0 (SP)	2	1	2	2527	A-15	164	80	50	89	64	13
800	C	2	1	3	2890	A-16	164	80	50	89	64	13
802	C	2	1	3	2890	A-16	164	80	50	89	64	13
803	C	2	1	3	2890	A-16	164	80	50	89	64	13
804	C	2	1	3	2890	A-16	164	80	50	89	64	13
806	C	2	1	3	2890	A-16	164	80	50	89	64	13
810	C	2	1	3	2890	A-16	164	80	50	89	64	13
812	C	2	1	3	2890	A-16	164	80	50	89	64	13
815	C	2	1	3	2890	A-16	164	80	50	89	64	13
817	C	2	1	3	2890	A-16	164	80	50	89	64	13
820	C	2	1	3	2890	A-16	164	80	50	89	64	13
821	C	2	1	3	2890	A-16	164	80	50	89	64	13
822	C	2	1	3	2890	A-16	164	80	50	89	64	13
823	C	2	1	3	2890	A-16	164	80	50	89	64	13
825	C	2	1	3	2890	A-16	164	80	50	89	64	13
826	C	2	1	3	2890	A-16	164	80	50	89	64	13
827	C	2	1	3	2890	A-16	164	80	50	89	64	13
828	C	2	1	3	2890	A-16	164	80	50	89	64	13
1949	EM 1	2	1	3	2464	A-19	164	80	50	89	64	13
1969	EM 1	2	1	3	2464	A-19	164	80	50	89	64	13
1971	EM 1	2	1	3	2464	A-19	164	80	50	89	64	13
1973	EM 1	2	1	3	2464	A-19	164	80	50	89	64	13
1975	EM 1	2	1	3	2464	A-19	164	80	50	89	64	13
1626	EM1	2	1	3	2464	A-19	164	80	50	89	64	13
1649	EM1	2	1	3	2464	A-19	164	80	50	89	64	13
1735	EM1	2	1	3	2464	A-19	164	80	50	89	64	13
1736	EM1	2	1	3	2464	A-19	164	80	50	89	64	13
1738	EM1	2	1	3	2464	A-19	164	80	50	89	64	13
1739	EM1	2	1	3	2464	A-19	164	80	50	89	64	13
1740	EM1	2	1	3	2464	A-19	164	80	50	89	64	13
1744	EM1	2	1	3	2464	A-19	164	80	50	89	64	13
1808	EM1	2	1	3	2464	A-19	164	80	50	89	64	13
1810	EM1	2	1	3	2464	A-19	164	80	50	89	64	13
1812	EM1	2	1	3	2464	A-19	164	80	50	89	64	13
1813	EM1	2	1	3	2464	A-19	164	80	50	89	64	13

NATURAL GAS LOADS - FAMILY HOUSING
FORT GORDON, GEORGIA

							CONNECTED LOAD (1000 BTUH)			EXPECTED PEAK LOAD (1000 BTUH)		
BUILDING NUMBER	QUARTER TYPE	NO. OF DU	STORIES	BR	AREA (SF)	DWG NO	FURNACE	HW HEAT	RANGE	FURNACE	HW HEAT	RANGE
1814	EM1	2	1	3	2464	A-19	164	80	50	89	64	13
1815	EM1	2	1	3	2464	A-19	164	80	50	89	64	13
1816	EM1	2	1	3	2464	A-19	164	80	50	89	64	13
1817	EM1	2	1	3	2464	A-19	164	80	50	89	64	13
1818	EM1	2	1	3	2464	A-19	164	80	50	89	64	13
1841	EM1	2	1	3	2464	A-19	164	80	50	89	64	13
1847	EM1	2	1	3	2464	A-19	164	80	50	89	64	13
1849	EM1	2	1	3	2464	A-19	164	80	50	89	64	13
1869	EM1	2	1	3	2464	A-19	164	80	50	89	64	13
1909	EM1	2	1	3	2464	A-19	164	80	50	89	64	13
1929	EM1	2	1	3	2464	A-19	164	80	50	89	64	13
1931	EM1	2	1	3	2464	A-19	164	80	50	89	64	13
1934	EM1	2	1	3	2464	A-19	164	80	50	89	64	13
1942	EM1	2	1	3	2464	A-19	164	80	50	89	64	13
2000	F	2	1	3	2627	A-30	164	80	50	89	64	13
2001	F	2	1	3	2627	A-30	164	80	50	89	64	13
2002	F	2	1	3	2627	A-30	164	80	50	89	64	13
2004	F	2	1	3	2627	A-30	164	80	50	89	64	13
2005	F	2	1	3	2627	A-30	164	80	50	89	64	13
2006	F	2	1	3	2627	A-30	164	80	50	89	64	13
2010	F	2	1	3	2627	A-30	164	80	50	89	64	13
2011	F	2	1	3	2627	A-30	164	80	50	89	64	13
2013	F	2	1	3	2627	A-30	164	80	50	89	64	13
2014	F	2	1	3	2627	A-30	164	80	50	89	64	13
2015	F	2	1	3	2627	A-30	164	80	50	89	64	13
2020	F	2	1	3	2627	A-30	164	80	50	89	64	13
2021	F	2	1	3	2627	A-30	164	80	50	89	64	13
2024	F	2	1	3	2627	A-30	164	80	50	89	64	13
2026	F	2	1	3	2627	A-30	164	80	50	89	64	13
2028	F	2	1	3	2627	A-30	164	80	50	89	64	13
2031	F	2	1	3	2627	A-30	164	80	50	89	64	13
2032	F	2	1	3	2627	A-30	164	80	50	89	64	13
2040	F	2	1	3	2627	A-30	164	80	50	89	64	13
2045	F	2	1	3	2627	A-30	164	80	50	89	64	13
2047	F	2	1	3	2627	A-30	164	80	50	89	64	13

NATURAL GAS LOADS - FAMILY HOUSING
FORT GORDON, GEORGIA

							CONNECTED LOAD (1000 BTUH)			EXPECTED PEAK LOAD (1000 BTUH)		
BUILDING NUMBER	QUARTER TYPE	NO. OF DU	STORIES	BR	AREA (SF)	DWG NO	FURNACE	HW HEAT	RANGE	FURNACE	HW HEAT	RANGE
2050	F	2	1	3	2627	A-30	164	80	50	89	64	13
2051	F	2	1	3	2627	A-30	164	80	50	89	64	13
2057	F	2	1	3	2627	A-30	164	80	50	89	64	13
2059	F	2	1	3	2627	A-30	164	80	50	89	64	13
2060	F	2	1	3	2627	A-30	164	80	50	89	64	13
2061	F	2	1	3	2627	A-30	164	80	50	89	64	13
2062	F	2	1	3	2627	A-30	164	80	50	89	64	13
2070	F	2	1	3	2627	A-30	164	80	50	89	64	13
2072	F	2	1	3	2627	A-30	164	80	50	89	64	13
2075	F	2	1	3	2627	A-30	164	80	50	89	64	13
2080	F	2	1	3	2627	A-30	164	80	50	89	64	13
2081	F	2	1	3	2627	A-30	164	80	50	89	64	13
2083	F	2	1	3	2627	A-30	164	80	50	89	64	13
2085	F	2	1	3	2627	A-30	164	80	50	89	64	13
2086	F	2	1	3	2627	A-30	164	80	50	89	64	13
830	A	2	1	4	3150	A-17	164	80	50	100	64	13
831	A	2	1	4	3150	A-17	164	80	50	100	64	13
832	A	2	1	4	3150	A-17	164	80	50	100	64	13
833	A	2	1	4	3150	A-17	164	80	50	100	64	13
834	A	2	1	4	3150	A-17	164	80	50	100	64	13
835	A	2	1	4	3150	A-17	164	80	50	100	64	13
836	A	2	1	4	3150	A-17	164	80	50	100	64	13
837	A	2	1	4	3150	A-17	164	80	50	100	64	13
838	A	2	1	4	3150	A-17	164	80	50	100	64	13
840	A	2	1	4	3150	A-17	164	80	50	100	64	13
841	A	2	1	4	3150	A-17	164	80	50	100	64	13
842	A	2	1	4	3150	A-17	164	80	50	100	64	13
843	A	2	1	4	3150	A-17	164	80	50	100	64	13
844	A	2	1	4	3150	A-17	164	80	50	100	64	13
845	A	2	1	4	3150	A-17	164	80	50	100	64	13
1644	EM 2	2	1	4	9314	A-20	164	80	50	100	64	13
1647	EM 2	2	1	4	9314	A-20	164	80	50	100	64	13
1652	EM 2	2	1	4	9314	A-20	164	80	50	100	64	13
1746	EM 2	2	1	4	9314	A-20	164	80	50	100	64	13
1822	EM 2	2	1	4	9314	A-20	164	80	50	100	64	13

NATURAL GAS LOADS - FAMILY HOUSING
FORT GORDON, GEORGIA

							CONNECTED LOAD (1000 BTUH)			EXPECTED PEAK LOAD (1000 BTUH)		
BUILDING NUMBER	QUARTER TYPE	NO. OF DU	STORIES	BR	AREA (SF)	DWG NO	FURNACE	HW HEAT	RANGE	FURNACE	HW HEAT	RANGE
1831	EM 2	2	1	4	9314	A-20	164	80	50	100	64	13
1836	EM 2	2	1	4	9314	A-20	164	80	50	100	64	13
1865	EM 2	2	1	4	9314	A-20	164	80	50	100	64	13
1870	EM 2	2	1	4	9314	A-20	164	80	50	100	64	13
1970	EM 2	2	1	4	9314	A-20	164	80	50	100	64	13
1643	EM 2A	2	1	4	2823	A-21	164	80	50	100	64	13
1654	EM 2A	2	1	4	2823	A-21	164	80	50	100	64	13
1801	EM 2A	2	1	4	2823	A-21	164	80	50	100	64	13
1803	EM 2A	2	1	4	2823	A-21	164	80	50	100	64	13
1804	EM 2A	2	1	4	2823	A-21	164	80	50	100	64	13
1806	EM 2A	2	1	4	2823	A-21	164	80	50	100	64	13
1820	EM 2A	2	1	4	2823	A-21	164	80	50	100	64	13
1834	EM 2A	2	1	4	2823	A-21	164	80	50	100	64	13
1863	EM 2A	2	1	4	2823	A-21	164	80	50	100	64	13
1902	EM 2A	2	1	4	2823	A-21	164	80	50	100	64	13
1905	EM 2A	2	1	4	2823	A-21	164	80	50	100	64	13
1913	EM 2A	2	1	4	2823	A-21	164	80	50	100	64	13
1922	EM 2A	2	1	4	2823	A-21	164	80	50	100	64	13
1944	EM 2A	2	1	4	2823	A-21	164	80	50	100	64	13
1947	EM 2A	2	1	4	2823	A-21	164	80	50	100	64	13
1955	EM 2A	2	1	4	2823	A-21	164	80	50	100	64	13
1964	EM 2A	2	1	4	2823	A-21	164	80	50	100	64	13
1924	EM 2A	2	1	4	2823	A-21	164	80	50	100	64	13
1819	1 EM 1 (SP)	2	2	3	3074	A-25	164	80	50	100	64	13
1844	1 EM 1 (SP)	2	2	3	3074	A-25	164	80	50	100	64	13
1846	1 EM 1 (SP)	2	2	3	3074	A-25	164	80	50	100	64	13
1848	1 EM 1 (SP)	2	2	3	3074	A-25	164	80	50	100	64	13
1871	1 EM 1 (SP)	2	2	3	3074	A-25	164	80	50	100	64	13
1907	1 EM 1 (SP)	2	2	3	3074	A-25	164	80	50	100	64	13
1911	1 EM 1 (SP)	2	2	3	3074	A-25	164	80	50	100	64	13
1914	1 EM 1 (SP)	2	2	3	3074	A-25	164	80	50	100	64	13
801	D	2	2	3	3074	A-18	164	80	50	100	64	13
805	D	2	2	3	3074	A-18	164	80	50	100	64	13
811	D	2	2	3	3074	A-18	164	80	50	100	64	13
813	D	2	2	3	3074	A-18	164	80	50	100	64	13

NATURAL GAS LOADS - FAMILY HOUSING
FORT GORDON, GEORGIA

							CONNECTED LOAD (1000 BTUH)			EXPECTED PEAK LOAD (1000 BTUH)		
BUILDING NUMBER	QUARTER TYPE	NO. OF DU	STORIES	BR	AREA (SF)	DWG NO	FURNACE	HW HEAT	RANGE	FURNACE	HW HEAT	RANGE
814	D	2	2	3	3074	A-18	164	80	50	100	64	13
816	D	2	2	3	3074	A-18	164	80	50	100	64	13
824	D	2	2	3	3074	A-18	164	80	50	100	64	13
1706	EM2	2	2	3	2851	A-26	164	80	50	100	64	13
1742	EM2	2	2	3	2851	A-26	164	80	50	100	64	13
1926	EM2	2	2	3	2851	A-26	164	80	50	100	64	13
1932	EM2	2	2	3	2851	A-26	164	80	50	100	64	13
1945	EM2	2	2	3	2851	A-26	164	80	50	100	64	13
1972	EM2	2	2	3	2851	A-26	164	80	50	100	64	13
2003	G	2	2	3	2763	A-31	164	80	50	100	64	13
2012	G	2	2	3	2763	A-31	164	80	50	100	64	13
2022	G	2	2	3	2763	A-31	164	80	50	100	64	13
2023	G	2	2	3	2763	A-31	164	80	50	100	64	13
2025	G	2	2	3	2763	A-31	164	80	50	100	64	13
2027	G	2	2	3	2763	A-31	164	80	50	100	64	13
2029	G	2	2	3	2763	A-31	164	80	50	100	64	13
2030	G	2	2	3	2763	A-31	164	80	50	100	64	13
2041	G	2	2	3	2763	A-31	164	80	50	100	64	13
2042	G	2	2	3	2763	A-31	164	80	50	100	64	13
2043	G	2	2	3	2763	A-31	164	80	50	100	64	13
2044	G	2	2	3	2763	A-31	164	80	50	100	64	13
2046	G	2	2	3	2763	A-31	164	80	50	100	64	13
2052	G	2	2	3	2763	A-31	164	80	50	100	64	13
2053	G	2	2	3	2763	A-31	164	80	50	100	64	13
2054	G	2	2	3	2763	A-31	164	80	50	100	64	13
2055	G	2	2	3	2763	A-31	164	80	50	100	64	13
2056	G	2	2	3	2763	A-31	164	80	50	100	64	13
2058	G	2	2	3	2763	A-31	164	80	50	100	64	13
2063	G	2	2	3	2763	A-31	164	80	50	100	64	13
2071	G	2	2	3	2763	A-31	164	80	50	100	64	13
2073	G	2	2	3	2763	A-31	164	80	50	100	64	13
2074	G	2	2	3	2763	A-31	164	80	50	100	64	13
2082	G	2	2	3	2763	A-31	164	80	50	100	64	13
2084	G	2	2	3	2763	A-31	164	80	50	100	64	13
757	ICG01	2	2	3	3100	A-13	164	80	50	100	64	13

NATURAL GAS LOADS - FAMILY HOUSING
FORT GORDON, GEORGIA

							CONNECTED LOAD (1000 BTUH)			EXPECTED PEAK LOAD (1000 BTUH)		
BUILDING NUMBER	QUARTER TYPE	NO. OF DU	STORIES	BR	AREA (SF)	DWG NO	FURNACE	HW HEAT	RANGE	FURNACE	HW HEAT	RANGE
759	ICG01	2	2	3	3100	A-13	164	80	50	100	64	13
760	ICG01	2	2	3	3100	A-13	164	80	50	100	64	13
749	IVFG01	2	2	3	3074	A-11	164	80	50	100	64	13
754	IVFG01	2	2	3	3074	A-11	164	80	50	100	64	13
1625	1 EM 2 (SP)	2	2	4	3202	A-27	164	80	50	87	64	13
1646	1 EM 2 (SP)	2	2	4	3202	A-27	164	80	50	87	64	13
1653	1 EM 2 (SP)	2	2	4	3202	A-27	164	80	50	87	64	13
1709	1 EM 2 (SP)	2	2	4	3202	A-27	164	80	50	87	64	13
1732	1 EM 2 (SP)	2	2	4	3202	A-27	164	80	50	87	64	13
1733	1 EM 2 (SP)	2	2	4	3202	A-27	164	80	50	87	64	13
1734	1 EM 2 (SP)	2	2	4	3202	A-27	164	80	50	87	64	13
1737	1 EM 2 (SP)	2	2	4	3202	A-27	164	80	50	87	64	13
1743	1 EM 2 (SP)	2	2	4	3202	A-27	164	80	50	87	64	13
1747	1 EM 2 (SP)	2	2	4	3202	A-27	164	80	50	87	64	13
1805	1 EM 2 (SP)	2	2	4	3202	A-27	164	80	50	87	64	13
1807	1 EM 2 (SP)	2	2	4	3202	A-27	164	80	50	87	64	13
1809	1 EM 2 (SP)	2	2	4	3202	A-27	164	80	50	87	64	13
1821	1 EM 2 (SP)	2	2	4	3202	A-27	164	80	50	87	64	13
1833	1 EM 2 (SP)	2	2	4	3202	A-27	164	80	50	87	64	13
1835	1 EM 2 (SP)	2	2	4	3202	A-27	164	80	50	87	64	13
1864	1 EM 2 (SP)	2	2	4	3202	A-27	164	80	50	87	64	13
1903	1 EM 2 (SP)	2	2	4	3202	A-27	164	80	50	87	64	13
1906	1 EM 2 (SP)	2	2	4	3202	A-27	164	80	50	87	64	13
1908	1 EM 2 (SP)	2	2	4	3202	A-27	164	80	50	87	64	13
1910	1 EM 2 (SP)	2	2	4	3202	A-27	164	80	50	87	64	13
1916	1 EM 2 (SP)	2	2	4	3202	A-27	164	80	50	87	64	13
1923	1 EM 2 (SP)	2	2	4	3202	A-27	164	80	50	87	64	13
1946	1 EM 2 (SP)	2	2	4	3202	A-27	164	80	50	87	64	13
1974	1 EM 2 (SP)	2	2	4	3202	A-27	164	80	50	87	64	13
767	ICG02	2	2	4	3202	A-14	164	80	50	87	64	13
748	IVFGO2	2	2	4	3390	A-12	164	80	50	87	64	13
750	IVFGO2	2	2	4	3390	A-12	164	80	50	87	64	13
752	IVFGO2	2	2	4	3390	A-12	164	80	50	87	64	13
1602	1 EM 1	4	1	3	7586	A-19	328	160	100	149	128	25
1622	1 EM 1	4	1	3	7586	A-19	328	160	100	149	128	25

NATURAL GAS LOADS - FAMILY HOUSING
FORT GORDON, GEORGIA

							CONNECTED LOAD (1000 BTUH)			EXPECTED PEAK LOAD (1000 BTUH)		
BUILDING NUMBER	QUARTER TYPE	NO. OF DU	STORIES	BR	AREA (SF)	DWG NO	FURNACE	HW HEAT	RANGE	FURNACE	HW HEAT	RANGE
1623	1 EM 1	4	1	3	7586	A-19	328	160	100	149	128	25
1624	1 EM 1	4	1	3	7586	A-19	328	160	100	149	128	25
1641	1 EM 1	4	1	3	7586	A-19	328	160	100	149	128	25
1722	1 EM 1	4	1	3	7586	A-19	328	160	100	149	128	25
1723	1 EM 1	4	1	3	7586	A-19	328	160	100	149	128	25
1724	1 EM 1	4	1	3	7586	A-19	328	160	100	149	128	25
1730	1 EM 1	4	1	3	7586	A-19	328	160	100	149	128	25
1731	1 EM 1	4	1	3	7586	A-19	328	160	100	149	128	25
1650	1 EM 1 (SP)	4	2	3	8543	A-25	328	160	100	149	128	25
1651	1 EM 1 (SP)	4	2	3	8543	A-25	328	160	100	149	128	25
1708	1 EM 1 (SP)	4	2	3	8543	A-25	328	160	100	149	128	25
1811	1 EM 1 (SP)	4	2	3	8543	A-25	328	160	100	149	128	25
1832	1 EM 1 (SP)	4	2	3	8543	A-25	328	160	100	149	128	25
1843	1 EM 1 (SP)	4	2	3	8543	A-25	328	160	100	149	128	25
1850	1 EM 1 (SP)	4	2	3	8543	A-25	328	160	100	149	128	25
1867	1 EM 1 (SP)	4	2	3	8543	A-25	328	160	100	149	128	25
1872	1 EM 1 (SP)	4	2	3	8543	A-25	328	160	100	149	128	25
1901	1 EM 1 (SP)	4	2	3	8543	A-25	328	160	100	149	128	25
1904	1 EM 1 (SP)	4	2	3	8543	A-25	328	160	100	149	128	25
1925	1 EM 1 (SP)	4	2	3	8543	A-25	328	160	100	149	128	25
1927	1 EM 1 (SP)	4	2	3	8543	A-25	328	160	100	149	128	25
1930	1 EM 1 (SP)	4	2	3	8543	A-25	328	160	100	149	128	25
1943	1 EM 1 (SP)	4	2	3	8543	A-25	328	160	100	149	128	25
1951	1 EM 1 (SP)	4	2	3	8543	A-25	328	160	100	149	128	25
1961	1 EM 1 (SP)	4	2	3	8543	A-25	328	160	100	149	128	25
1962	1 EM 1 (SP)	4	2	3	8543	A-25	328	160	100	149	128	25
1656	1 EM 2	4	2	3	8543	A-26	328	160	100	149	128	25
1701	1 EM 2	4	2	3	8543	A-26	328	160	100	149	128	25
1729	1 EM 2	4	2	3	8543	A-26	328	160	100	149	128	25
1627	EM 12D	4	2	3	8543	A-22	328	160	100	149	128	25
1628	EM 12D	4	2	3	8543	A-22	328	160	100	149	128	25
1629	EM 12D	4	2	3	8543	A-22	328	160	100	149	128	25
1707	EM 12D	4	2	3	8543	A-22	328	160	100	149	128	25
1915	EM 12D	4	2	3	8543	A-22	328	160	100	149	128	25
1966	EM 12D	4	2	3	8543	A-22	328	160	100	149	128	25

NATURAL GAS LOADS - FAMILY HOUSING
FORT GORDON, GEORGIA

							CONNECTED LOAD (1000 BTUH)			EXPECTED PEAK LOAD (1000 BTUH)		
BUILDING NUMBER	QUARTER TYPE	NO. OF DU	STORIES	BR	AREA (SF)	DWG NO	FURNACE	HW HEAT	RANGE	FURNACE	HW HEAT	RANGE
1645	EM 12U	4	2	3	5771	A-23	328	160	100	149	128	25
1952	EM 12U	4	2	3	5771	A-23	328	160	100	149	128	25
1953	EM 12U	4	2	3	5771	A-23	328	160	100	149	128	25
1954	EM 12U	4	2	3	5771	A-23	328	160	100	149	128	25
758	ICG01	4	2	3	3100	A-13	328	160	100	149	128	25
765	ICG01	4	2	3	3100	A-13	328	160	100	149	128	25
768	ICG01	4	2	3	3100	A-13	328	160	100	149	128	25
1727	III EM 4B	4	2	3	8234	A-28	328	160	100	149	128	25
1748	III EM 5B	4	2	3	8469		328	160	100	149	128	25
1750	III EM 5B	4	2	3	8469		328	160	100	149	128	25
1642	1 EM 2 (SP)	4	2	4	8800	A-27	328	160	100	149	128	25
1648	1 EM 2 (SP)	4	2	4	8800	A-27	328	160	100	149	128	25
1802	1 EM 2 (SP)	4	2	4	8800	A-27	328	160	100	149	128	25
1838	1 EM 2 (SP)	4	2	4	8800	A-27	328	160	100	149	128	25
1842	1 EM 2 (SP)	4	2	4	8800	A-27	328	160	100	149	128	25
1845	1 EM 2 (SP)	4	2	4	8800	A-27	328	160	100	149	128	25
1866	1 EM 2 (SP)	4	2	4	8800	A-27	328	160	100	149	128	25
1873	1 EM 2 (SP)	4	2	4	8800	A-27	328	160	100	149	128	25
1912	1 EM 2 (SP)	4	2	4	8800	A-27	328	160	100	149	128	25
1921	1 EM 2 (SP)	4	2	4	8800	A-27	328	160	100	149	128	25
1928	1 EM 2 (SP)	4	2	4	8800	A-27	328	160	100	149	128	25
1933	1 EM 2 (SP)	4	2	4	8800	A-27	328	160	100	149	128	25
1941	1 EM 2 (SP)	4	2	4	8800	A-27	328	160	100	149	128	25
1948	1 EM 2 (SP)	4	2	4	8800	A-27	328	160	100	149	128	25
1950	1 EM 2 (SP)	4	2	4	8800	A-27	328	160	100	149	128	25
1601	1 EM 1	6	1	3	7586	A-19	492	240	150	196	192	38
1655	1 EM 1	6	1	3	7586	A-19	492	240	150	196	192	38
1657	1 EM 1	6	1	3	7586	A-19	492	240	150	196	192	38
1721	1 EM 1	6	1	3	7586	A-19	492	240	150	196	192	38
1728	1 EM 1	6	1	3	7586	A-19	492	240	150	196	192	38
1603	1 EM2	6	1	4	9314	A-20	492	240	150	196	192	38
1621	1 EM2	6	1	4	9314	A-20	492	240	150	196	192	38
1741	1 EM 1 (SP)	6	2	3	8198	A-25	492	240	150	196	192	38
1745	1 EM 1 (SP)	6	2	3	8198	A-25	492	240	150	196	192	38
1837	1 EM 1 (SP)	6	2	3	8198	A-25	492	240	150	196	192	38

NATURAL GAS LOADS - FAMILY HOUSING
FORT GORDON, GEORGIA

BUILDING NUMBER	QUARTER TYPE	NO. OF DU	STORIES	BR	AREA (SF)	DWG NO	CONNECTED LOAD (1000 BTUH) FURNACE	CONNECTED LOAD (1000 BTUH) HW HEAT	CONNECTED LOAD (1000 BTUH) RANGE	EXPECTED PEAK LOAD (1000 BTUH) FURNACE	EXPECTED PEAK LOAD (1000 BTUH) HW HEAT	EXPECTED PEAK LOAD (1000 BTUH) RANGE
1851	1 EM 1 (SP)	6	2	3	8198	A-25	492	240	150	196	192	38
1862	1 EM 1 (SP)	6	2	3	8198	A-25	492	240	150	196	192	38
1868	1 EM 1 (SP)	6	2	3	8198	A-25	492	240	150	196	192	38
1956	1 EM 1 (SP)	6	2	3	8198	A-25	492	240	150	196	192	38
1963	1 EM 1 (SP)	6	2	3	8198	A-25	492	240	150	196	192	38
1968	1 EM 1 (SP)	6	2	3	8198	A-25	492	240	150	196	192	38
1702	1 EM 2	6	2	3	9314	A-26	492	240	150	196	192	38
1726	1 EM 2	6	2	3	9314	A-26	492	240	150	196	192	38
1630	EM 12D	6	2	3	8543	A-22	492	240	150	196	192	38
1861	EM 12D	6	2	3	8543	A-22	492	240	150	196	192	38
1965	EM 12D	6	2	3	8543	A-22	492	240	150	196	192	38
1967	EM 12D	6	2	3	8543	A-22	492	240	150	196	192	38
1703	III EM 4B	6	2	3	8234	A-28	492	240	150	196	192	38
1704	III EM 4B	6	2	3	8234	A-28	492	240	150	196	192	38
1705	III EM 4B	6	2	3	8234	A-28	492	240	150	196	192	38
1725	III EM 5B	6	2	3	8469		492	240	150	196	192	38
1749	III EM 5B	6	2	3	8469		492	240	150	196	192	38
761	ICG02	6	2	4	10222	A-14	492	240	150	196	192	38
771	ICG01	8	2	3		A-13	656	320	200	272	256	50
		875	UNITS		1,452,113		71,858	35,120	21,875	36,936	28,096	5,469
								128,853 TOTAL			70,501 TOTAL	

NATURAL GAS LOADS - FAMILY HOUSING
FORT GORDON, GEORGIA

CALCULATED HEAT LOSS FROM SAMPLE UNITS

SAMPLE BUILDING	DWELLING UNITS	STORIES	BR	HEAT LOSS (BTUH)	SIMILAR HOUSING UNITS
3 BR COL	1	1	3	70	4 BR COL, IVSO4, GENERAL, IVFG01
EM1	2	1	3	89	CGO(SP), C, EM1, F
EM2	2	2	3	100	A, EM2, EM 2A, 1EM1(SP), D, EM2, G, ICGO1, IVFG01
1EM2(SP)	2	2	4	87	1EM2(SP), ICGO2, IVFG02
1EM1(SP)	4	2	3	149	1EM1, 1EM2, EM 12D, EM 12U, ICGO1, III EM 4B, III EM 5B
1EM2(SP)	4	2	4	149	1EM2(SP)
1EM1(SP)	6	2	3	196	1EM1, 1EM2, 1EM1(SP), EM 12D, III EM 4B, III EM 5B, ICGO2
ICGO1	8	2	3	272	

ASSUMED DIVERSITIES FOR ESTIMATED PEAK LOAD

HOT WATER HEATER	80%
COOKING RANGE	25%
OVERALL DIVERSITY	55%

CALCULATED VALUES

TOTAL CONNECTED LOAD	128,853
TOTAL HOUSING AREA	1,452,113
OVERALL BTU/SF	89

NATURAL GAS LOADS - BUILDINGS
FORT GORDON, GEORGIA

					TOTAL CONNECTED LOAD (1000 BTUH)							ESTIMATED LOAD DURING CURTAILMENT (1000 BTUH)					
BLDG NO	DESCRIPTIO	SOURCE	PERM/ TEMP	BUILDING AREA (SF)	FURN	STM BOILER	HW BOILER	HW HTR	OTHER	TOTAL	REMARKS	FURN	STM BOILER	HW BOILER	HW HTR	OTHER	TOTAL
C1301	CE BLDG	N/A	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
250	GRIFFITH	N/A	P	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
300	HOSPITAL	SE	P	582,080					900	900	KITCHEN	0	0	0	0	225	225
310	EAMC PLAN		P							0		0	0	0	0	0	0
320	DENTAL	SE	P	27,091						0		0	0	0	0	0	0
322	DENTAL LAB	N/A	P	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
352	OLD HOSPIT	N/A	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
2200	LAUNDRY	SE	T	56,779					3,200	3,200	DRYERS	0	0	0	0	800	800
2202	LAUN PLT	N/A	P	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
2212	COLD STOR	CE	P	23,794		500		365		865		0	125	0	146	0	271
14600	CE MAINT	N/A	P	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
15500	BOWLING C	SE	P	13,602	510					510		255	0	0	0	0	255
18400	EM CLUB	SE	P	31,284		5,950		365	1,100	7,415	KITCHEN	0	1,488	0	146	275	1,909
18402	NCO CLUB	SE	P	17,606	1,560			80		1,640		780	0	0	32	0	812
18404	BILLETING	CE	P	1,480		5,950		200		6,150		0	1,488	0	80	0	1,568
19140	SPORTS AR	SE/CE	T	21,576		3,350		95		3,445		0	838	0	38	0	876
19160	CHAPEL	CE	T	3,278		500				500		0	125	0	0	0	125
20301	MOTOR POO	N/A	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
20302	MOTOR POO	N/A	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
20303	MOTOR POO	N/A	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
20304	MOTOR POO	N/A	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
20801	MOTOR POO	N/A	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
21301	MOTOR POO	N/A	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
21303	MOTOR POO	N/A	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
21305	MOTOR POO	N/A	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
21307	MOTOR POO	N/A	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
21308	MOTOR POO	N/A	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
21604	ADMIN-1	SE	P	5,537				36		36		0	0	0	14	0	14
21605	ADMIN-1	21604	P	5,537	0	0	0	36	0	36		0	0	0	14	0	14
21606	EM REC CE	SE	P	17,728					80	80	GRILLS	0	0	0	0	20	20
21608	INDOOR PO	SE	P	23,991		2,730		365		3,095		0	683	0	146	0	829
21610	THEATRE	N/A	P	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
21706	ADMIN-2	SE	P	12,623				34		34		0	0	0	14	0	14
21709	MESS HALL-	SE	P	9,243		1,826		300	900	3,026	KITCHEN	0	457	0	120	225	802
21710	HQ-1	SE	P	4,539				40		40		0	0	0	16	0	16
21711	PX-1	SE	P	4,617				30		30		0	0	0	12	0	12
21712	HEALTH CLI	SE	P	4,617						0		0	0	0	0	0	0
21714	ADMIN-2	21706	P	11,636	0	0	0	34	0	34		0	0	0	14	0	14
21717	MESS HALL-	21709	P	12,623	0	1,826	0	300	900	3,026	KITCHEN	0	457	0	120	225	802
21719	ADMIN-2	21706	P	11,636	0	0	0	34	0	34		0	0	0	14	0	14
21722	MESS HALL-	21709	P	12,623	0	1,826	0	300	900	3,026	KITCHEN	0	457	0	120	225	802
21804	MOTOR POO	CE	P	4,849				65		65		0	0	0	26	0	26
21805	MOTOR POO	CE	P	4,576				40		40		0	0	0	16	0	16
21806	MOTOR POO	CE	P	4,576				40		40		0	0	0	16	0	16
21807	MOTOR POO	CE	P	4,576				40		40		0	0	0	16	0	16
22303	MOTOR POO	N/A	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
22307	MOTOR POO	N/A	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
24414	MESS HALL-	SE	P	20,205		1,680			1,900	3,580	KITCHEN	0	420	0	0	475	895
25330	CEN PLT-2	N/A	P	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
25423	MESS HALL-	SE	P	17,952						0		0	0	0	0	0	0

NATURAL GAS LOADS - BUILDINGS
FORT GORDON, GEORGIA

					TOTAL CONNECTED LOAD (1000 BTUH)							ESTIMATED LOAD DURING CURTAILMENT (1000 BTUH)					
BLDG NO	DESCRIPTIO	SOURCE	PERM/ TEMP	BUILDING AREA (SF)	FURN	STM BOILER	HW BOILER	HW HTR	OTHER	TOTAL	REMARKS	FURN	STM BOILER	HW BOILER	HW HTR	OTHER	TOTAL
25501	DENTAL CLI	N/A	P	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
25601	ADMIN-1	21604	P	5,537	0	0	0	36	0	36		0	0	0	14	0	14
25602	ADMIN-1	21604	P	5,537	0	0	0	36	0	36		0	0	0	14	0	14
25603	CHAPEL	SE	P	7,574						0		0	0	0	0	0	0
25604	ADMIN-1	21604	P	5,537	0	0	0	36	0	36		0	0	0	14	0	14
25605	ADMIN-1	21604	P	5,537	0	0	0	36	0	36		0	0	0	14	0	14
25701	ADMIN-2	21706	P	11,636	0	0	0	34	0	34		0	0	0	14	0	14
25704	MESS HALL-	21709	P	12,623	0	1,826	0	300	900	3,026	KITCHEN	0	457	0	120	225	802
25706	ADMIN-2	21706	P	11,636	0	0	0	34	0	34		0	0	0	14	0	14
25709	MESS HALL-	21709	P	12,623	0	1,826	0	300	900	3,026	KITCHEN	0	457	0	120	225	802
25710	HQ-1	21710	P	9,243	0	0	0	40	0	40		0	0	0	16	0	16
25711	PX-1	21711	P	4,539	0	0	0	30	0	30		0	0	0	12	0	12
25712	DISP-1	21712	P	4,617	0	0	0	0	0	0		0	0	0	0	0	0
25714	ADMIN-2	21706	P	11,636	0	0	0	34	0	34		0	0	0	14	0	14
25717	MESS HALL-	21709	P	12,623	0	1,826	0	300	900	3,026	KITCHEN	0	457	0	120	225	802
25719	ADMIN-2	21706	P	11,636	0	0	0	34	0	34		0	0	0	14	0	14
25722	MESS HALL-	21709	P	12,623	0	1,826	0	300	900	3,026	KITCHEN	0	457	0	120	225	802
25910	CEN PLT-1		P	17,952						0		0	0	0	0	0	0
28423	MESS HALL	SE	P	18,623						0		0	0	0	0	0	0
29300	AUTO SHOP	SE	P	18,623					1,350	1,350	UNIT HTR	0	0	0	0	338	338
29601	ADMIN-1	21604	P	5,537	0	0	0	36	0	36		0	0	0	14	0	14
29602	ADMIN-1	21604	P	5,537	0	0	0	36	0	36		0	0	0	14	0	14
29603	HQ-1	21710	P	9,243	0	0	0	40	0	40		0	0	0	16	0	16
29604	PX-1	21711	P	4,539	0	0	0	30	0	30		0	0	0	12	0	12
29605	DISP-1	21712	P	4,617	0	0	0	0	0	0		0	0	0	0	0	0
29608	CHAPEL	SE	P	7,888						0		0	0	0	0	0	0
29609	ADMIN-1	21710	P	9,243	0	0	0	40	0	40		0	0	0	16	0	16
29610	DIOM COMP	CE	P	11,320						0		0	0	0	0	0	0
29701	ADMIN-2	21706	P	11,636	0	0	0	34	0	34		0	0	0	14	0	14
29704	MESS HALL-	21709	P	12,623	0	1,826	0	300	900	3,026	KITCHEN	0	457	0	120	225	802
29706	ADMIN-2	21706	P	11,636	0	0	0	34	0	34		0	0	0	14	0	14
29709	MESS HALL-	21709	P	12,623	0	1,826	0	300	900	3,026	KITCHEN	0	457	0	120	225	802
29714	ADMIN-2	21706	P	11,636	0	0	0	34	0	34		0	0	0	14	0	14
29719	ADMIN-2	21706	P	11,636	0	0	0	34	0	34		0	0	0	14	0	14
29722	MESS HALL-	21709	P	12,623	0	1,826	0	300	900	3,026	KITCHEN	0	457	0	120	225	802
29808	SIGNAL TO	SE	P	112,002			1,450			1,450		0	0	363	0	0	363
30503	CLOTHING	N/A	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
30504	CLOTHING	N/A	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
31418	CLOTHING	N/A	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
31501		N/A	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
32100	DINNER THE	N/A	P	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
32420		N/A	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
32422		N/A	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
32503	JAG	N/A	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
33200	BOWLING C	N/A	P	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
33423		N/A	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
33500	LIBRARY	N/A	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
33513	TELEPHON	SE	P	6,400						0		0	0	0	0	0	0
33601	ADMIN	SE	P	13,568	225					225		113	0	0	0	0	113
33800	CHILD CARE	SE	P	29,142				300	400	700	KITCHEN	0	0	0	120	100	220

NATURAL GAS LOADS - BUILDINGS
FORT GORDON, GEORGIA

					TOTAL CONNECTED LOAD (1000 BTUH)							ESTIMATED LOAD DURING CURTAILMENT (1000 BTUH)					
BLDG NO	DESCRIPTIO	SOURCE	PERM/ TEMP	BUILDING AREA (SF)	FURN	STM BOILER	HW BOILER	HW HTR	OTHER	TOTAL	REMARKS	FURN	STM BOILER	HW BOILER	HW HTR	OTHER	TOTAL
35200	MAIN PX	N/A	P	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
35402	BURGER KIN	SE	P	2,950					1,300	1,300		0	0	0	0	325	325
36302	POST OFFIC	CE	P	10,085			375	40		415		0	0	94	16	0	110
36305	SIGNAL MUS	SE	P	3,108						0		0	0	0	0	0	0
36700	RING	N/A	P	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
37300	STINSON	CE	P	29,292				354	165	519	DRYER	0	0	0	142	41	183
37302	STINSON	SE	P	7,364				670	165	835	DRYER	0	0	0	268	41	309
39001	BREMS	SE	P	3,893						0		0	0	0	0	0	0
39005	BREMS	SE	P	6,008	400			160		560		200	0	0	64	0	264
39006	BREMS	39005	P	6,008	400	0	0	160	0	560		200	0	0	64	0	264
39007	BREMS	SE	P	2,848						0		0	0	0	0	0	0
39010	BREMS	39005	P	6,008	400	0	0	160	0	560		200	0	0	64	0	264
39101	BREMS	39005	P	6,008	400	0	0	160	0	560		200	0	0	64	0	264
39102	BREMS	39005	P	6,008	400	0	0	160	0	560		200	0	0	64	0	264
39103	BREMS	40115	P	3,040	200	0	0	0	0	200		100	0	0	0	0	100
39105	BREMS	SE	P	4,696		1,890			1,087	2,977	KITCHEN	0	473	0	0	272	744
39107	BREMS	40115	P	3,040	200	0	0	0	0	200		100	0	0	0	0	100
39109	BREMS	40115	P	3,040	200	0	0	0	0	200		100	0	0	0	0	100
39110	BREMS	40115	P	3,040	200	0	0	0	0	200		100	0	0	0	0	100
39111	BREMS	SE	P	2,128	200			42		242		100	0	0	17	0	117
39113	BREMS	40115	P	3,040	200					200		100	0	0	0	0	100
39114	BREMS	40115	P	3,040	200					200		100	0	0	0	0	100
39115	BREMS	40115	P	3,040	200					200		100	0	0	0	0	100
39117	BREMS	SE	P	4,936		2,975			0	2,975		0	744	0	0	0	744
39119	BREMS	40115	P	3,040	200	0	0	0	0	200		100	0	0	0	0	100
39121	BREMS	40115	P	3,040	200	0	0	0	0	200		100	0	0	0	0	100
39122	BREMS	40115	P	3,040	200	0	0	0	0	200		100	0	0	0	0	100
39123	BREMS	39005	P	6,008	400	0	0	160	0	560		200	0	0	64	0	264
39124	BREMS	39005	P	6,008	400	0	0	160	0	560		200	0	0	64	0	264
39125	BREMS	40115	P	3,040	200	0	0	0	0	200		100	0	0	0	0	100
39127	BREMS	39105	P	4,696	0	1,890	0	0	0	1,890		0	473	0	0	0	473
39211	BREMS	SE	P	3,914	150					150		75	0	0	0	0	75
40001	BREMS	39001	P	3,893	0	0	0	0	0	0		0	0	0	0	0	0
40005	BREMS	39001	P	3,893	0	0	0	0	0	0		0	0	0	0	0	0
40006	BREMS	39001	P	3,893	0	0	0	0	0	0		0	0	0	0	0	0
40007	BREMS	40115	P	3,040	200	0	0	0	0	200		100	0	0	0	0	100
40101	BREMS	39005	P	6,008	400	0	0	160	0	560		200	0	0	64	0	264
40102	BREMS	39005	P	6,008	400	0	0	160	0	560		200	0	0	64	0	264
40103	BREMS	40115	P	3,040	200	0	0	0	0	200		100	0	0	0	0	100
40105	BREMS	39105	P	4,696	0	1,890	0	0	0	1,890		0	473	0	0	0	473
40107	BREMS	40115	P	3,040	200	0	0	0	0	200		100	0	0	0	0	100
40109	BREMS	39005	P	6,008	400	0	0	160	0	560		200	0	0	64	0	264
40110	BREMS	39005	P	6,008	400	0	0	160	0	560		200	0	0	64	0	264
40113	BREMS	39005	P	6,008	400	0	0	160	0	560		200	0	0	64	0	264
40114	BREMS	39005	P	6,008	400	0	0	160	0	560		200	0	0	64	0	264
40115	BREMS	SE	P	3,040	200					200		100	0	0	0	0	100
40117	BREMS	39105	P	4,696	0	1,890	0	0	0	1,890		0	473	0	0	0	473
40119	BREMS	39105	P	4,696	0	1,890	0	0	0	1,890		0	473	0	0	0	473
40121	BREMS	39105	P	4,696	0	1,890	0	0	0	1,890		0	473	0	0	0	473
40122	BREMS	39105	P	4,696	0	1,890	0	0	0	1,890		0	473	0	0	0	473

NATURAL GAS LOADS - BUILDINGS
FORT GORDON, GEORGIA

					TOTAL CONNECTED LOAD (1000 BTUH)							ESTIMATED LOAD DURING CURTAILMENT (1000 BTUH)					
BLDG NO	DESCRIPTIO	SOURCE	PERM/ TEMP	BUILDING AREA (SF)	FURN	STM BOILER	HW BOILER	HW HTR	OTHER	TOTAL	REMARKS	FURN	STM BOILER	HW BOILER	HW HTR	OTHER	TOTAL
40123	BREMS	39105	P	4,696	0	1,890	0	0	0	1,890		0	473	0	0	0	473
40124	BREMS	39105	P	4,696	0	1,890	0	0	0	1,890		0	473	0	0	0	473
40125	BREMS	40115	P	3,040	200	0	0	0	0	200		100	0	0	0	0	100
40127	BREMS	SE	P	4,936					1,087	1,087		0	0	0	0	272	272
40200	BREMS	39211	P	3,914	150	0	0	0	0	150		75	0	0	0	0	75
40201	BREMS	SE	P	3,041						0		0	0	0	0	0	0
40202	BREMS	40201	P	3,041	0	0	0	0	0	0		0	0	0	0	0	0
40203	BREMS	40201	P	3,041	0	0	0	0	0	0		0	0	0	0	0	0
41101	BREMS	40201	P	3,041	0	0	0	0	0	0		0	0	0	0	0	0
41102	BREMS	40201	P	3,041	0	0	0	0	0	0		0	0	0	0	0	0
41103	BREMS	40201	P	3,041	0	0	0	0	0	0		0	0	0	0	0	0
41104	BREMS	40201	P	3,041	0	0	0	0	0	0		0	0	0	0	0	0
41105	BREMS	40201	P	3,041	0	0	0	0	0	0		0	0	0	0	0	0
41201	BREMS	40201	P	3,041	0	0	0	0	0	0		0	0	0	0	0	0
41202	BREMS	40201	P	3,041	0	0	0	0	0	0		0	0	0	0	0	0
41203	BREMS	40201	P	3,041	0	0	0	0	0	0		0	0	0	0	0	0
41204	BREMS	40201	P	3,041	0	0	0	0	0	0		0	0	0	0	0	0
41205	BREMS	40201	P	3,041	0	0	0	0	0	0		0	0	0	0	0	0
61405	BREMS	N/A	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
71406	BREMS	N/A	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
	TOTAL CONNECTED LOAD (1000 BTU/HR)			1,775,646	11,195	58,905	1,825	9,053	21,734	102,712		5,598	14,726	456	3,621	5,434	29,835
170	BUILDINGS TOTAL																

NATURAL GAS LOADS - BUILDINGS
FORT GORDON, GEORGIA

ASSUMED DIVERSITIES FOR ESTIMATED PEAK LOAD

FURNACES/HVAC	50%
STEAM BOILERS	25%
HOT WATER BOILERS	25%
HOT WATER HEATERS	40%
KITCHENS	25%

CALCULATED VALUES

TOTAL CONNECTED LOAD (BUILDINGS)	102,712,000	BTU/HR
TOTAL EST LOAD @ PEAK	29,834,700	BTU/HR
OVERALL DIVERSITY	29%	

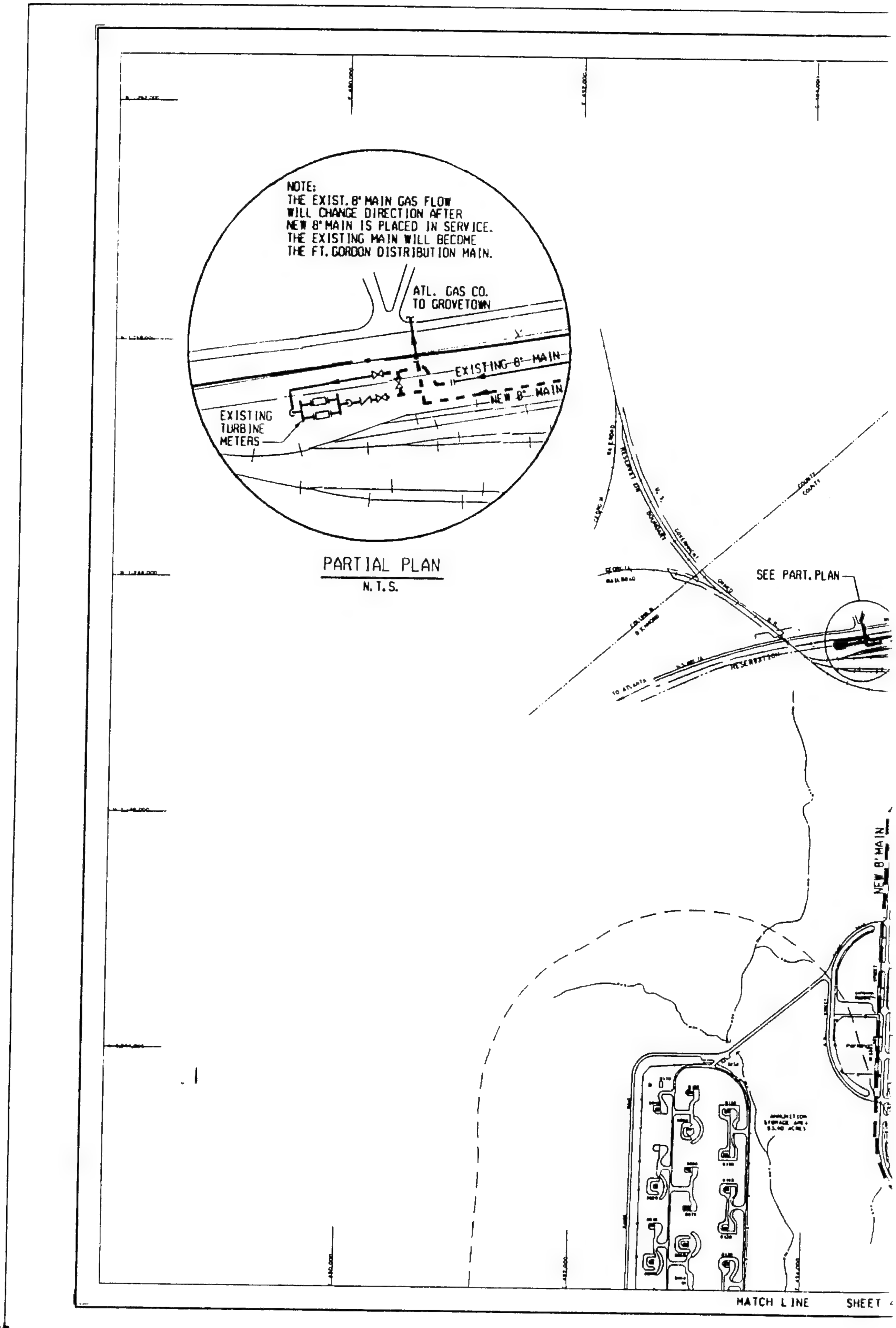
TOTAL CONNECTED LOAD (BUILDINGS)	102,712,000	BTU/HR
TOTAL BUILDING AREA	1,775,646	SF
OVERALL BTU / SF	58	BTUH/SF

SIMONS

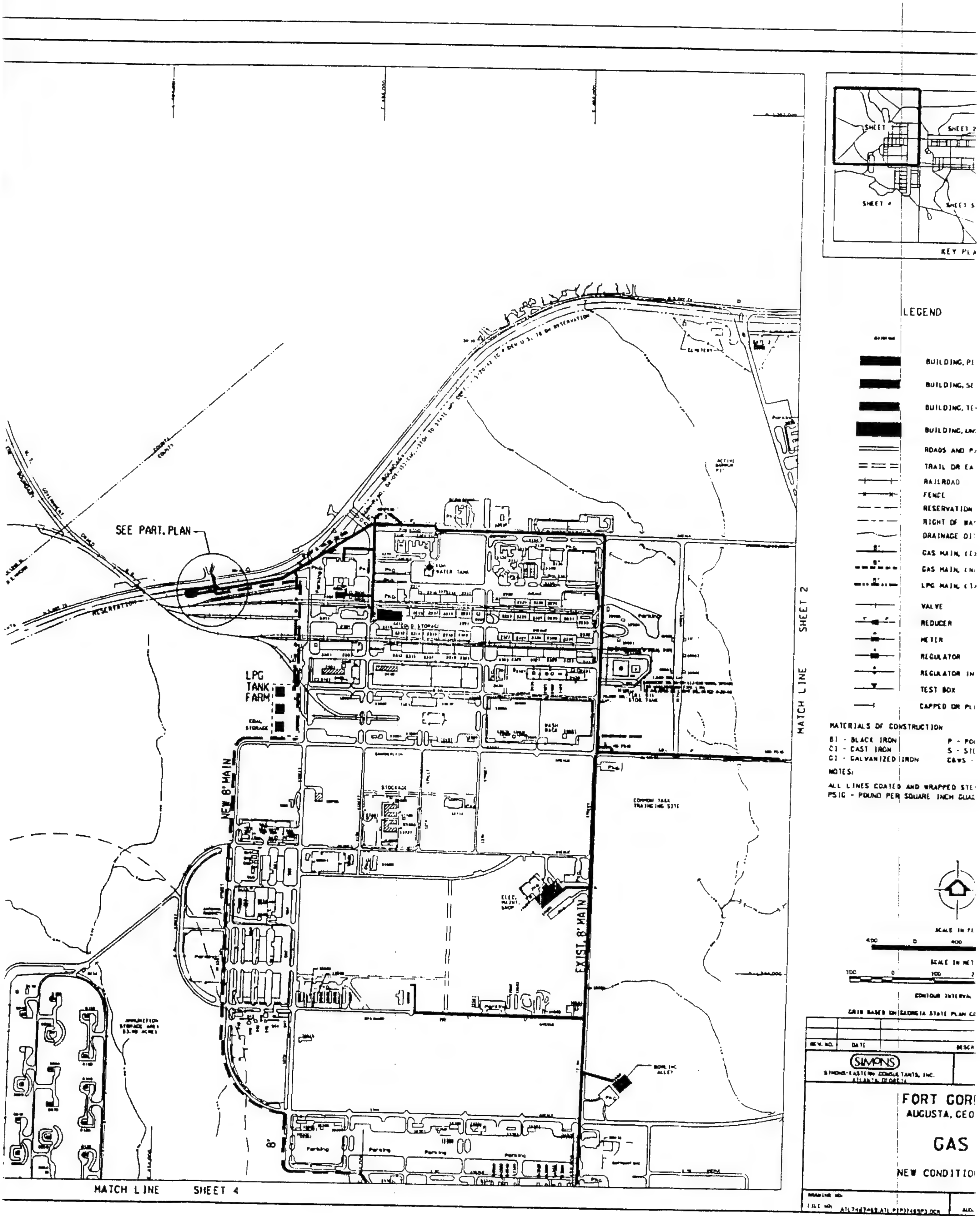
NATURAL GAS LOADS - FUTURE BUILDINGS
FORT GORDON, GEORGIA

DESCRIPTION	FY	SF	ESTIMATED BTUH *
Army Reserve Center	FY-91	79,200	4,581,313
Family Practice Clinic	FY-91	32,400	1,874,174
Clinical Investigation Lab	FY-94	25,000	1,446,122
Consol. Field Maint. Facility	FY-95	184,000	10,643,455
Training Aids Facility	FY-96+	78,000	4,511,899
Physical Fitness Center	FY-96+	24,600	1,422,984
Emergency Services Complex	FY-96+	11,000	636,293
TOTAL ESTIMATED CONNECTED LOAD			25,116,240

* HEAT LOAD BASED ON AVERAGE CONNECTED LOAD/SF OF THE 132 BUILDINGS SURVEYED.

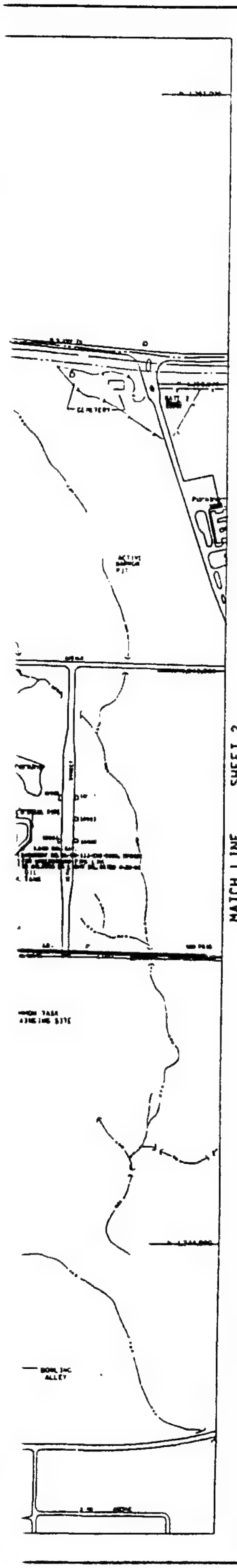

NOTE:
THE EXIST. 8" MAIN GAS FLOW
WILL CHANGE DIRECTION AFTER
NEW 8" MAIN IS PLACED IN SERVICE.
THE EXISTING MAIN WILL BECOME
THE FT. GORDON DISTRIBUTION MAIN.
ATL. GAS CO.
TO GROVETOWN
EXISTING 8" MAIN
NEW 8" MAIN
EXISTING
TURBINE
METERS
PARTIAL PLAN
N.T.S.
SEE PART. PLAN
NEW 8" MAIN
MATCH LINE
SHEET

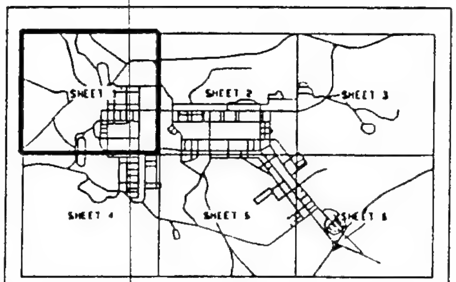
①



SEE PART. PLAN
LPG
TANK
FARM
NEW 8" MAIN
EXIST. 8" MAIN
8"
STOCKADE
ELEC.
MAINT.
SHOP
WATER TANK
COLD STORAGE
COMMON TASK
TRAINING SITE
BOWLING
ALLEY
ACTIVE
BARROW
PIT
CEMETERY
MATCH LINE SHEET 2
MATCH LINE SHEET 4
KEY PLA
LEGEND
BUILDING, PE
BUILDING, SE
BUILDING, TE
BUILDING, UN
ROADS AND P
TRAIL OR EA
RAILROAD
FENCE
RESERVATION
RIGHT OF WA
DRAINAGE DI
GAS MAIN, (E
GAS MAIN, (N
LPG MAIN, (
VALVE
REDUCER
METER
REGULATOR
REGULATOR IN
TEST BOX
CAPPED OR PL
MATERIALS OF CONSTRUCTION
BI - BLACK IRON
CI - CAST IRON
GI - GALVANIZED IRON
NOTES:
ALL LINES COATED AND WRAPPED STE
PSIG - POUND PER SQUARE INCH GUAG
CONTOUR INTERVAL
SIMONS
SIMONS-EASTERN CONSULTANTS, INC.
ATLANTA, GEORGIA
FORT GOR
AUGUSTA, GEO
GAS
NEW CONDITIO

2





KEY PLAN

LEGEND

	BUILDING, PERMANENT
	BUILDING, SEMI-PERMANENT
	BUILDING, TEMPORARY
	BUILDING, UNDERGROUND
	ROADS AND PARKING
	TRAIL OR EARTH ROAD
	RAILROAD
	FENCE
	RESERVATION BOUNDRY
	RIGHT OF WAY OR EASEMENT
	DRAINAGE DITCH
	GAS MAIN (EXISTING)
	GAS MAIN (NEW)
	LPG MAIN (TANK FARM TO GAS MAIN)
	VALVE
	REDUCER
	METER
	REGULATOR
	REGULATOR IN MANHOLE
	TEST BOX
	CAPPED OR PLUGGED

MATERIALS OF CONSTRUCTION

BI - BLACK IRON
CI - CAST IRON
GI - GALVANIZED IRON
P - POLYETHELENE
S - STEEL
C&WS - COATED AND WRAPPED STEEL

NOTES:

ALL LINES COATED AND WRAPPED STEEL UNLESS NOTED OTHERWISE
PSIG - POUND PER SQUARE INCH GUAGE

SCALE IN FEET

400 0 400 800 1200

SCALE IN METERS

100 0 100 200 300 400

CONTOUR INTERVAL 5 FEET

GRID BASED ON GEORGIA STATE PLAN COORDINATE SYSTEM, EAST ZONE

REV. NO.	DATE	DESCRIPTION	INITIAL

SIMONS
SIMONS-EASTERN CONSULTANTS, INC.
ATLANTA, GEORGIA

U.S. ARMY CORPS OF ENGINEERS
SAVANNAH DISTRICT
SAVANNAH, GEORGIA

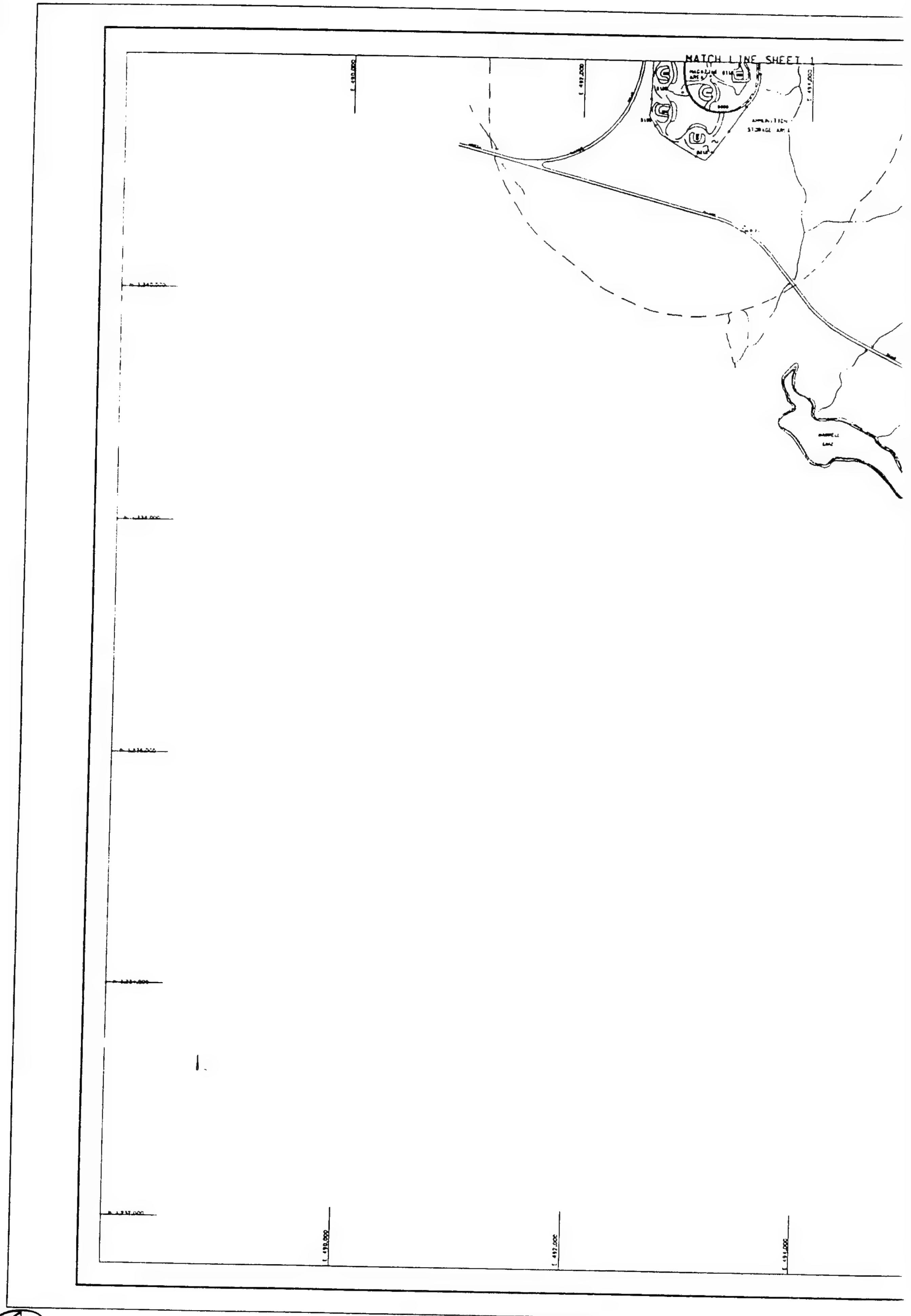
FORT GORDON
AUGUSTA, GEORGIA

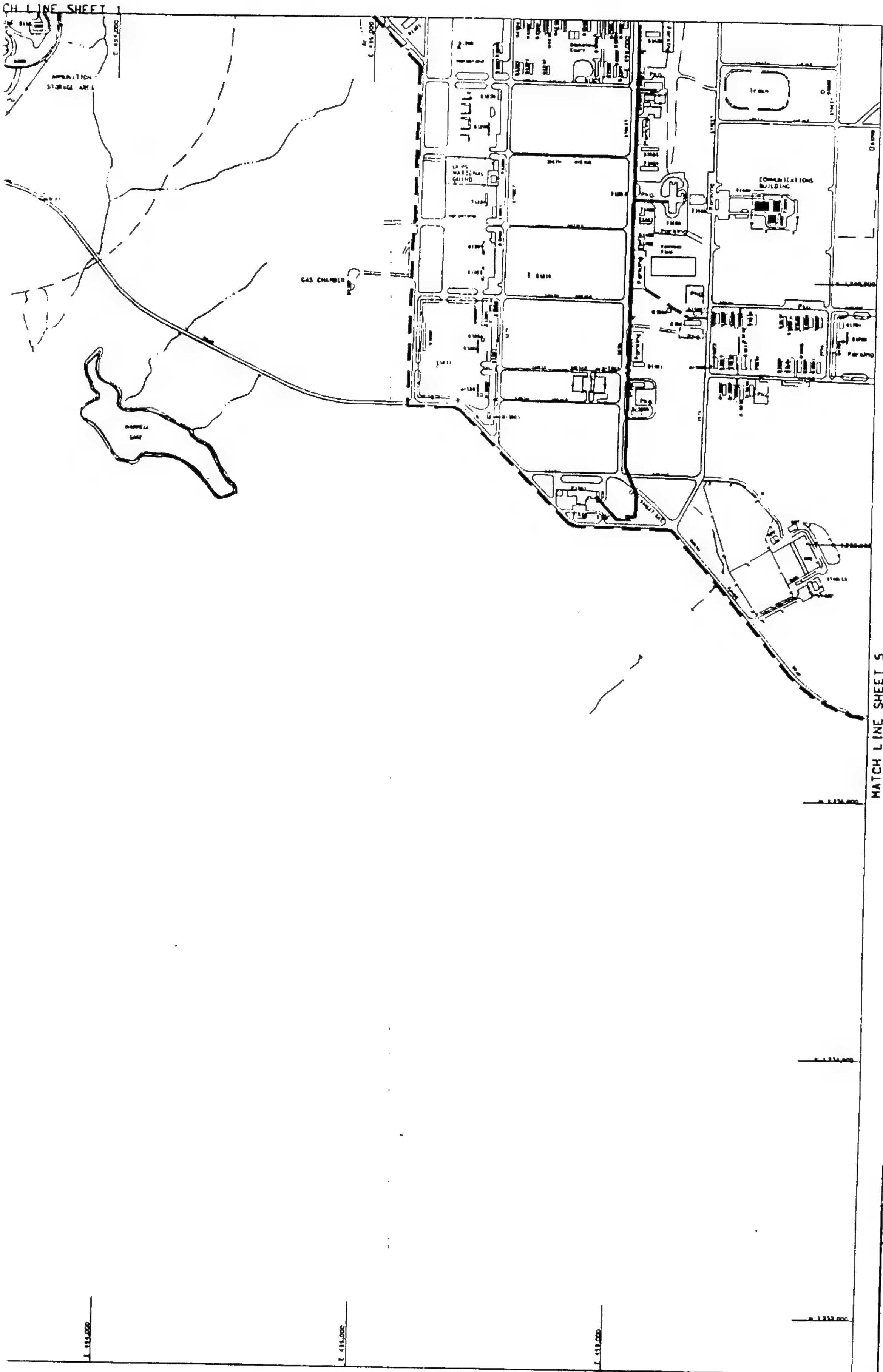
GAS

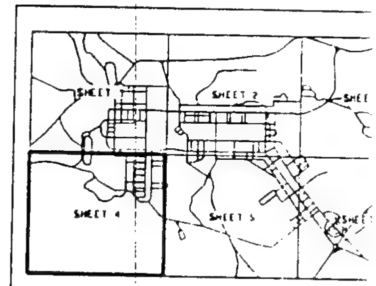
NEW CONDITIONS MAPS

DRAWING NO.	DATE	SHEET NO.
FILE NO. ATL74\\7459.ATL.P1P7\\7459P3.DCS	AUGUST 12, 1992	1 OF 6

3


MATCH LINE SHEET 1
E 490,000
E 492,000
E 494,000





KEY PLAN

LEGEND

BUILDING, PERMANENT
BUILDING, SEMI-PERMANENT
BUILDING, TEMPORARY
BUILDING, UNDERGROUND
ROADS AND PARKING
TRAIL OR EARTH ROAD
RAILROAD
FENCE
RESERVATION BOUNDRY
RIGHT OF WAY OR EASEMENT
DRAINAGE DITCH
GAS MAIN, (EXISTING)
GAS MAIN, (NEW)
LPG MAIN, (TANK FARM TO GAS H
VALVE
REDUCER
METER
REGULATOR
REGULATOR IN MANHOLE
TEST BOX
CAPPED OR PLUGGED

MATERIALS OF CONSTRUCTION

BI - BLACK IRON
CI - CAST IRON
GI - GALVANIZED IRON
P - POLYETHELENE
S - STEEL
C&WS - COATED AND WRAPP

NOTES:

ALL LINES COATED AND WRAPPED STEEL UNLESS NOTED O
PSIG - POUND PER SQUARE INCH GUAGE

SCALE IN FEET

400 0 400 800 1200

SCALE IN METERS

100 0 100 200 300

CONTOUR INTERVAL 5 FEET

GRID BASED ON GEORGIA STATE PLAN COORDINATE SYSTEM EAST

REV. NO.	DATE	DESCRIPTION

SIMONS

SIMONS-EASTERN CONSULTANTS, INC.
ATLANTA, GEORGIA

U.S. ARMY CORPS OF E
SAVANNAH DISTR
SAVANNAH, GEORG

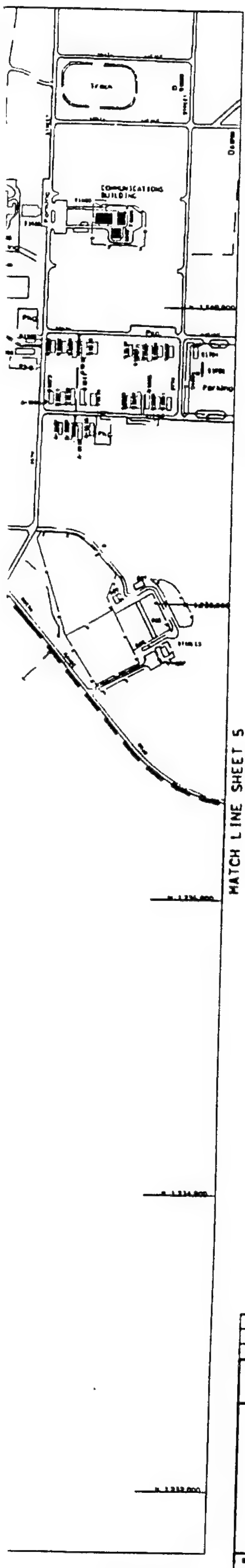
FORT GORDON
AUGUSTA, GEORGIA

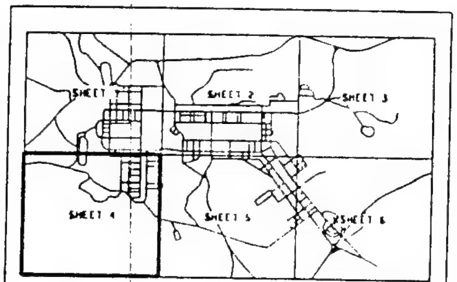
GAS

NEW CONDITIONS MAPS

DRAWING NO.
FILE NO. ATL7447469 ATL P1P1174696+DGN
DATE AUGUST 18, 1997

②





KEY PLAN

LEGEND

BUILDING, PERMANENT
BUILDING, SEMI-PERMANENT
BUILDING, TEMPORARY
BUILDING, UNDERGROUND
ROADS AND PARKING
TRAIL OR EARTH ROAD
RAILROAD
FENCE
RESERVATION BOUNDARY
RIGHT OF WAY OR EASEMENT
DRAINAGE DITCH
GAS MAIN, (EXISTING)
GAS MAIN, (NEW)
LPG MAIN, (TANK FARM TO GAS MAIN)
VALVE
REDUCER
METER
REGULATOR
REGULATOR IN MANHOLE
TEST BOX
CAPPED OR PLUGGED

MATERIALS OF CONSTRUCTION

BI - BLACK IRON
CI - CAST IRON
GI - GALVANIZED IRON
P - POLYETHELENE
S - STEEL
C&WS - COATED AND WRAPPED STEEL

NOTES:

ALL LINES COATED AND WRAPPED STEEL UNLESS NOTED OTHERWISE
PSIG - POUND PER SQUARE INCH GUAGE

SCALE IN FEET

400 0 400 800 1200

SCALE IN METERS

100 0 100 200 300 400

CONTOUR INTERVAL 5 FEET

GRID BASED ON GEORGIA STATE PLAN COORDINATE SYSTEM, EAST ZONE

REV. NO.	DATE	DESCRIPTION	INITIAL

SIMONS
SIMONS-EASTERN CONSULTANTS, INC.
ATLANTA, GEORGIA

U.S. ARMY CORPS OF ENGINEERS
SAVANNAH DISTRICT
SAVANNAH, GEORGIA

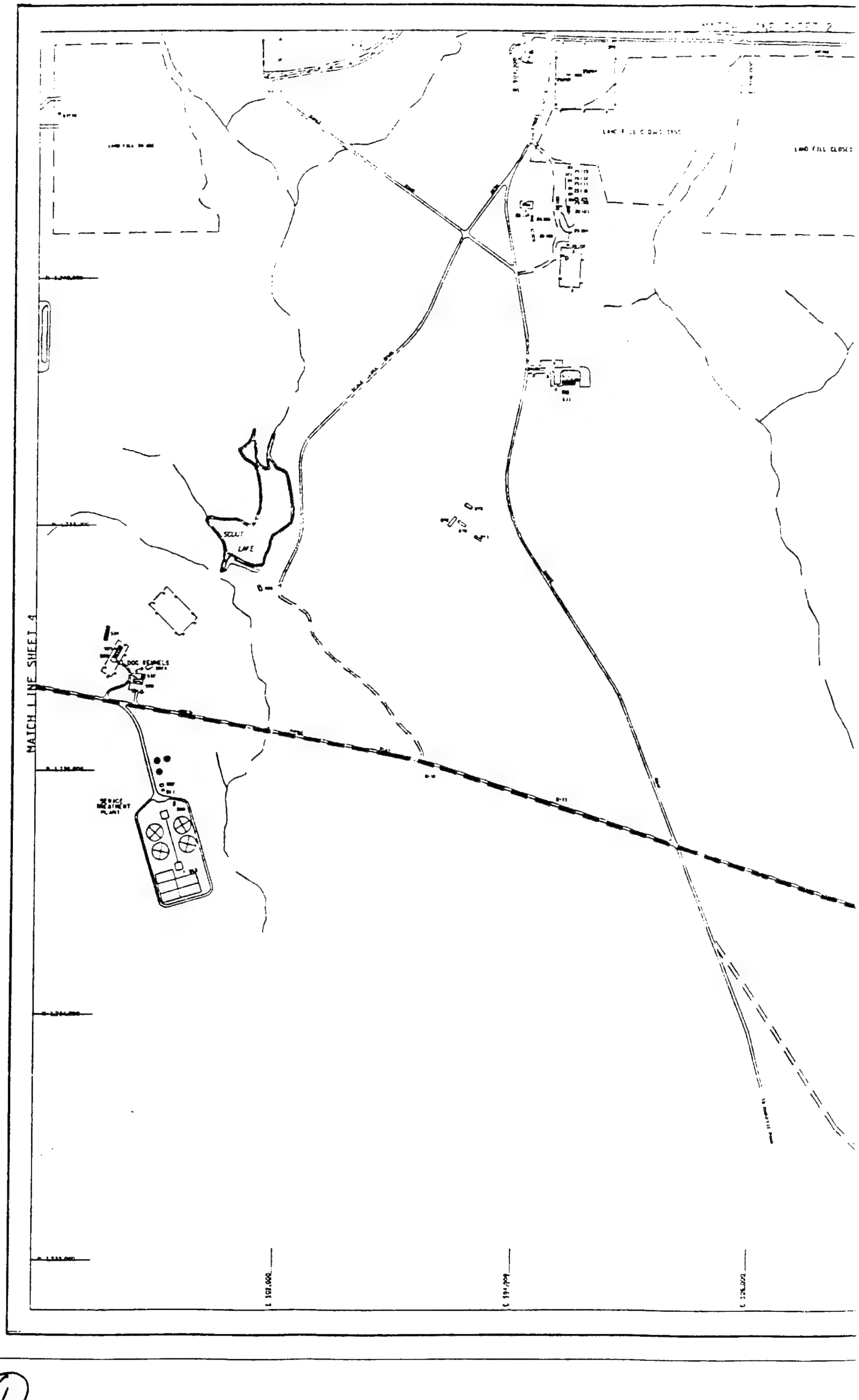
FORT GORDON
AUGUSTA, GEORGIA

GAS

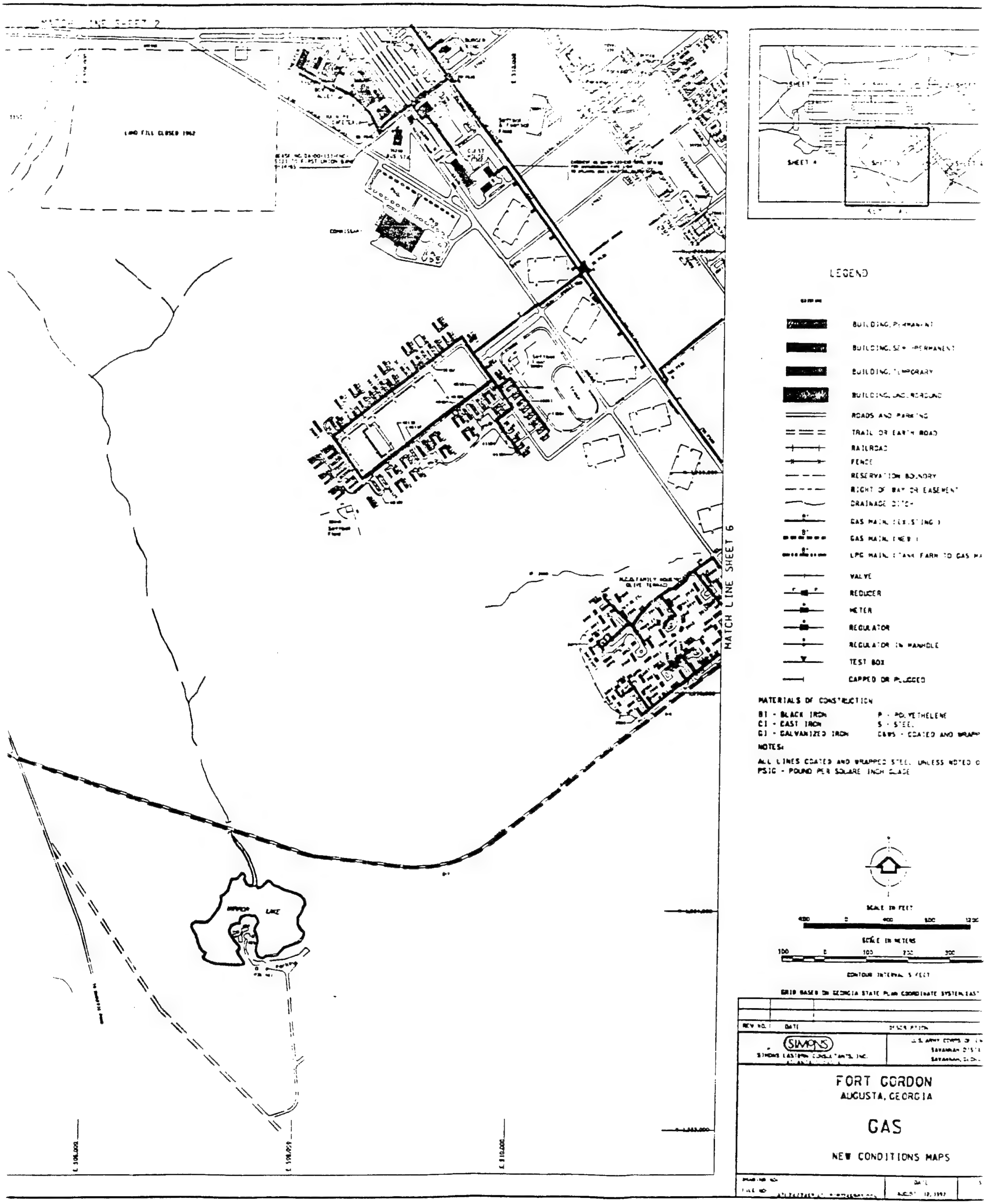
NEW CONDITIONS MAPS

DRAWING NO. FILE NO.	DATE	SHEET NO.
[illegible]	AUGUST 12, 1997	4 OF 6

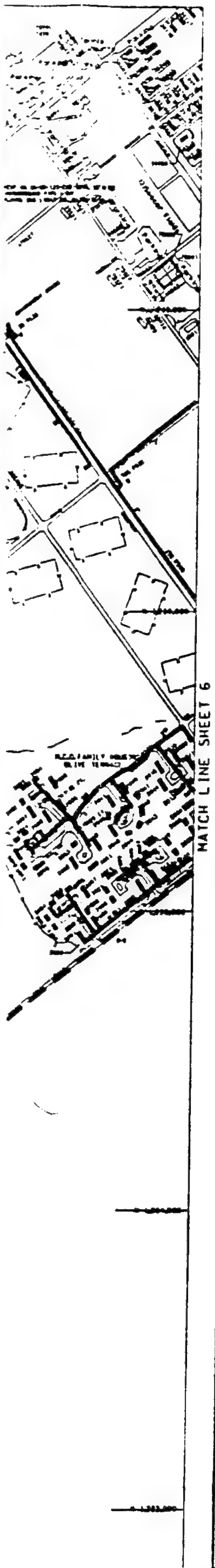
3

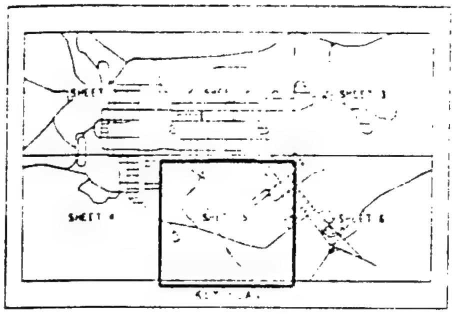


1



LAND FILL CLOSED 1962
COMMISSARY
MATCH LINE SHEET 6
LEGEND
BUILDING, PERMANENT
BUILDING, SEMI-PERMANENT
BUILDING, TEMPORARY
BUILDING, UNDERGROUND
ROADS AND PARKING
TRAIL OR EARTH ROAD
RAILROAD
FENCE
RESERVATION BOUNDARY
RIGHT OF WAY OR EASEMENT
DRAINAGE DITCH
GAS MAIN (EXISTING)
GAS MAIN (NEW)
VALVE
REDUCER
METER
REGULATOR
REGULATOR IN MANHOLE
TEST BOX
CAPPED OR PLUGGED
MATERIALS OF CONSTRUCTION
BI - BLACK IRON
CI - CAST IRON
GI - GALVANIZED IRON
P - POLYETHELENE
S - STEEL
NOTES:
ALL LINES COATED AND WRAPPED STEEL UNLESS NOTED
PSIG - POUND PER SQUARE INCH GAGE
SCALE IN FEET
SCALE IN METERS
SIMONS
FORT GORDON
AUGUSTA, GEORGIA
GAS
NEW CONDITIONS MAPS





LEGEND

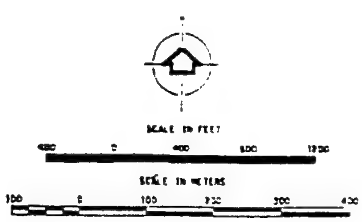
- BUILDING, PERMANENT
- BUILDING, SEMI-PERMANENT
- BUILDING, TEMPORARY
- BUILDING, UNDERGROUND
- ROADS AND PARKING
- TRAIL OR EARTH ROAD
- RAILROAD
- FENCE
- RESERVATION BOUNDRY
- RIGHT OF WAY OR EASEMENT
- DRAINAGE DITCH
- GAS MAIN (EXISTING)
- GAS MAIN (NEW)
- LPG MAIN (TANK FARM TO GAS MAIN)
- VALVE
- REDUCER
- METER
- REGULATOR
- REGULATOR IN MANHOLE
- TEST BOX
- CAPPED OR PLUGGED

MATERIALS OF CONSTRUCTION

BI - BLACK IRON	P - POLYETHELENE
CI - CAST IRON	S - STEEL
GI - GALVANIZED IRON	C&WS - COATED AND WRAPPED STEEL

NOTES:

ALL LINES COATED AND WRAPPED STEEL UNLESS NOTED OTHERWISE
PSIG - POUND PER SQUARE INCH GUAGE



CONTOUR INTERVAL 5 FEET

GRID BASED ON GEORGIA STATE PLAN COORDINATE SYSTEM EAST ZONE

REV NO.	DATE	DESCRIPTION	INITIAL

SIMONS
SIMONS EASTERN CONSULTANTS, INC.

U.S. ARMY CORPS OF ENGINEERS
SAVANNAH DISTRICT
SAVANNAH, GEORGIA

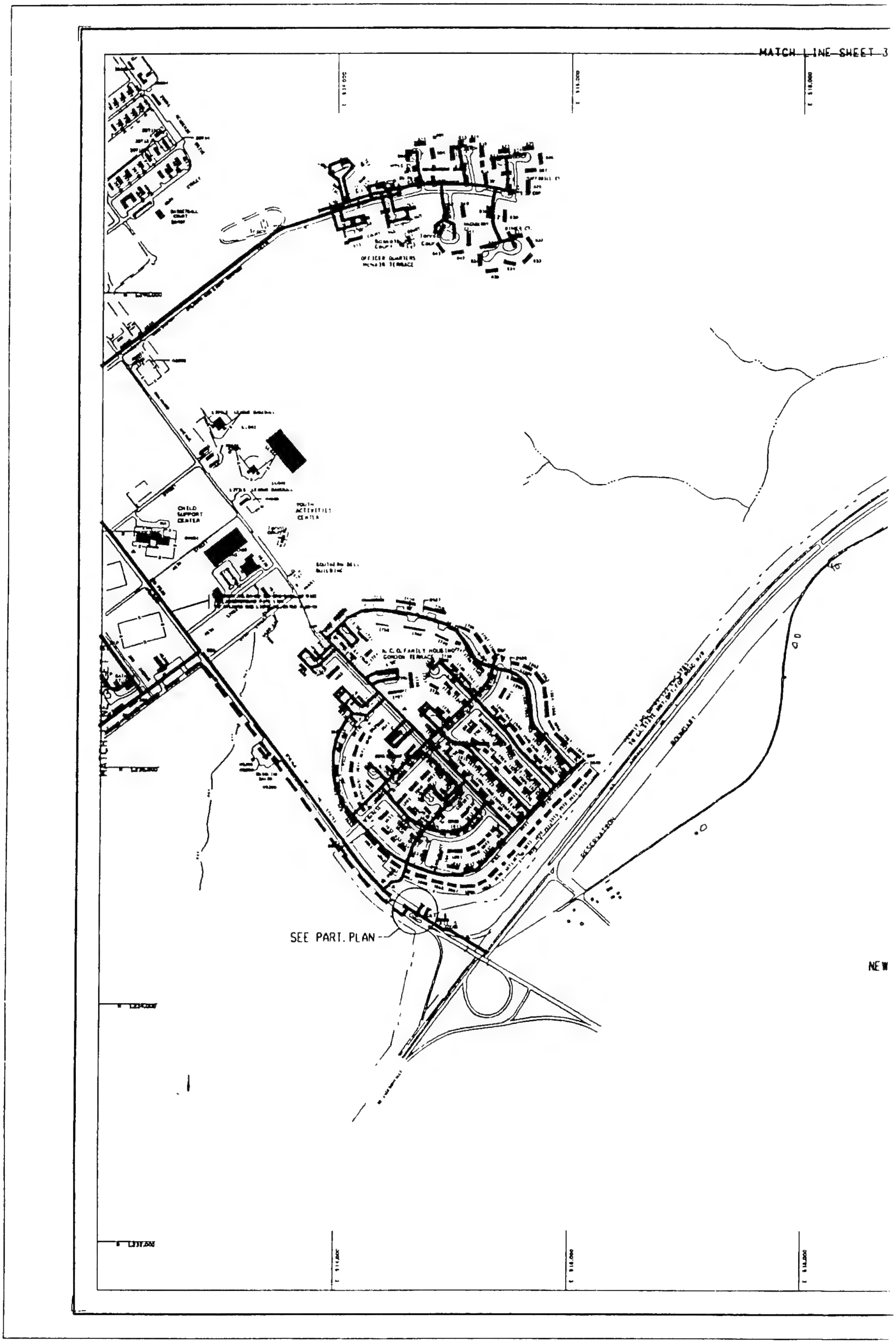
FORT GORDON
AUGUSTA, GEORGIA

GAS

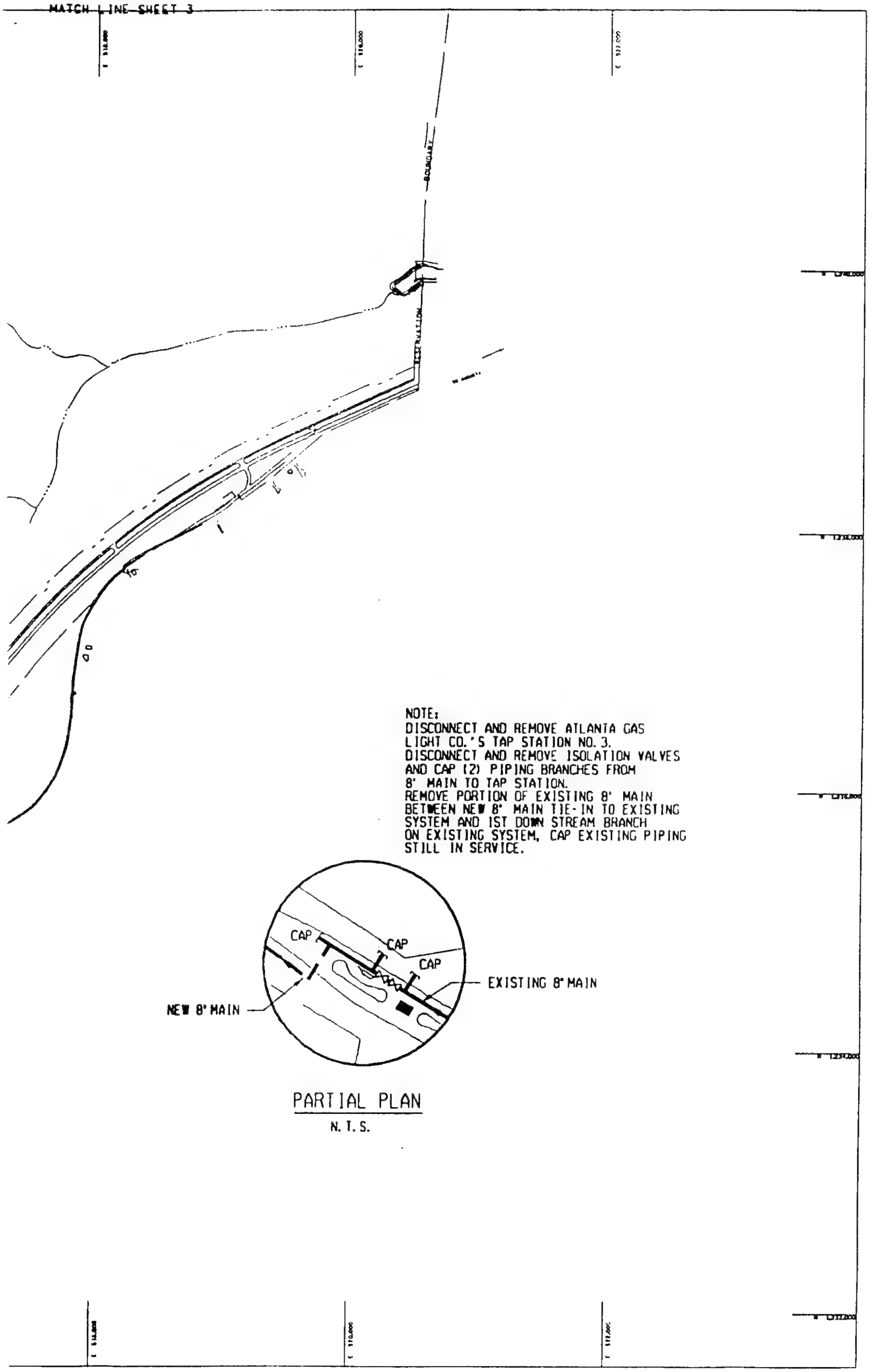
NEW CONDITIONS MAPS

DRAWING NO.	DATE	SHEET NO.
FILE NO.	AUGUST 19, 1992	5 OF 6

3

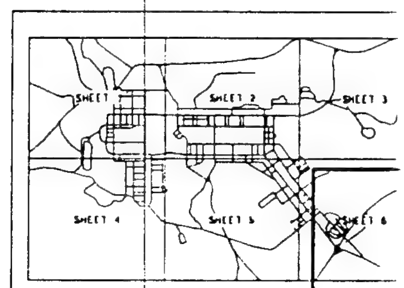

MATCH LINE SHEET 3
OFFICER QUARTERS
CHILD SUPPORT CENTER
YOUTH ACTIVITIES CENTER
N.C.O. FAMILY HOUSING
GORDON TERRACE
SEE PART. PLAN
NEW

1



NOTE:
DISCONNECT AND REMOVE ATLANTA GAS LIGHT CO.'S TAP STATION NO. 3.
DISCONNECT AND REMOVE ISOLATION VALVES AND CAP (2) PIPING BRANCHES FROM 8" MAIN TO TAP STATION.
REMOVE PORTION OF EXISTING 8" MAIN BETWEEN NEW 8" MAIN TIE-IN TO EXISTING SYSTEM AND 1ST DOWN STREAM BRANCH ON EXISTING SYSTEM, CAP EXISTING PIPING STILL IN SERVICE.

PARTIAL PLAN
N.T.S.



KEY PLAN

LEGEND

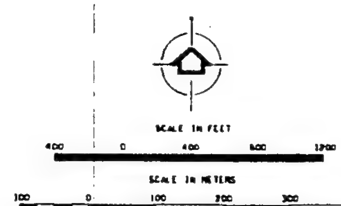
- BUILDING, PERMANENT
- BUILDING, SEMI-PERMANENT
- BUILDING, TEMPORARY
- BUILDING, UNDERGROUND
- ROADS AND PARKING
- TRAIL OR EARTH ROAD
- RAILROAD
- FENCE
- RESERVATION BOUNDRY
- RIGHT OF WAY OR EASEMENT
- DRAINAGE DITCH
- GAS MAIN, (EXISTING)
- GAS MAIN, (NEW)
- LPG MAIN, (TANK FARM TO GAS MAI
- VALVE
- REDUCER
- METER
- REGULATOR
- REGULATOR IN MANHOLE
- TEST BOX
- CAPPED OR PLUGGED

MATERIALS OF CONSTRUCTION

BI - BLACK IRON
CI - CAST IRON
GI - GALVANIZED IRON
P - POLYETHELENE
S - STEEL
C&WS - COATED AND WRAPPED

NOTES:

ALL LINES COATED AND WRAPPED STEEL UNLESS NOTED OTH
PSIG - POUND PER SQUARE INCH GUAGE



CONTOUR INTERVAL 5 FEET

GRID BASED ON GEORGIA STATE PLAN COORDINATE SYSTEM EAST Z

REV. NO.	DATE	DESCRIPTION

SIMONS
SIMONS-EASTERN CONSULTANTS, INC.
ATLANTA, GEORGIA

U.S. ARMY CORPS OF ENG
SAVANNAH DISTRIC
SAVANNAH, GEORGIA

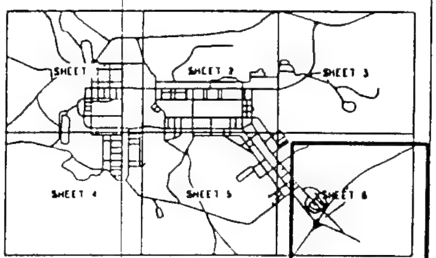
FORT GORDON
AUGUSTA, GEORGIA

GAS

NEW CONDITIONS MAPS

DRAWING NO.	DATE	SH
FILE NO.	AUGUST 12, 1992	6

2



KEY PLAN

S
G
NG

LEGEND

	BUILDING, PERMANENT
	BUILDING, SEMI-PERMANENT
	BUILDING, TEMPORARY
	BUILDING, UNDERGROUND
	ROADS AND PARKING
	TRAIL OR EARTH ROAD
	RAILROAD
	FENCE
	RESERVATION BOUNDARY
	RIGHT OF WAY OR EASEMENT
	DRAINAGE DITCH
	GAS MAIN, (EXISTING)
	GAS MAIN, (NEW)
	LPG MAIN, (TANK FARM TO GAS MAIN)
	VALVE
	REDUCER
	METER
	REGULATOR
	REGULATOR IN MANHOLE
	TEST BOX
	CAPPED OR PLUGGED

MATERIALS OF CONSTRUCTION

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CI - CAST IRON
GI - GALVANIZED IRON
P - POLYETHELENE
S - STEEL
C&WS - COATED AND WRAPPED STEEL

NOTES:

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PSIG - POUND PER SQUARE INCH GUAGE

SCALE IN FEET

400 0 400 800 1200

SCALE IN METERS

100 0 100 200 300 400

CONTOUR INTERVAL 5 FEET

GRID BASED ON GEORGIA STATE PLAN COORDINATE SYSTEM EAST ZONE

REV. NO.	DATE	DESCRIPTION	INITIAL

SIMONS
SIMONS-EASTERN CONSULTANTS, INC.
ATLANTA, GEORGIA

U.S. ARMY CORPS OF ENGINEERS
SAVANNAH DISTRICT
SAVANNAH, GEORGIA

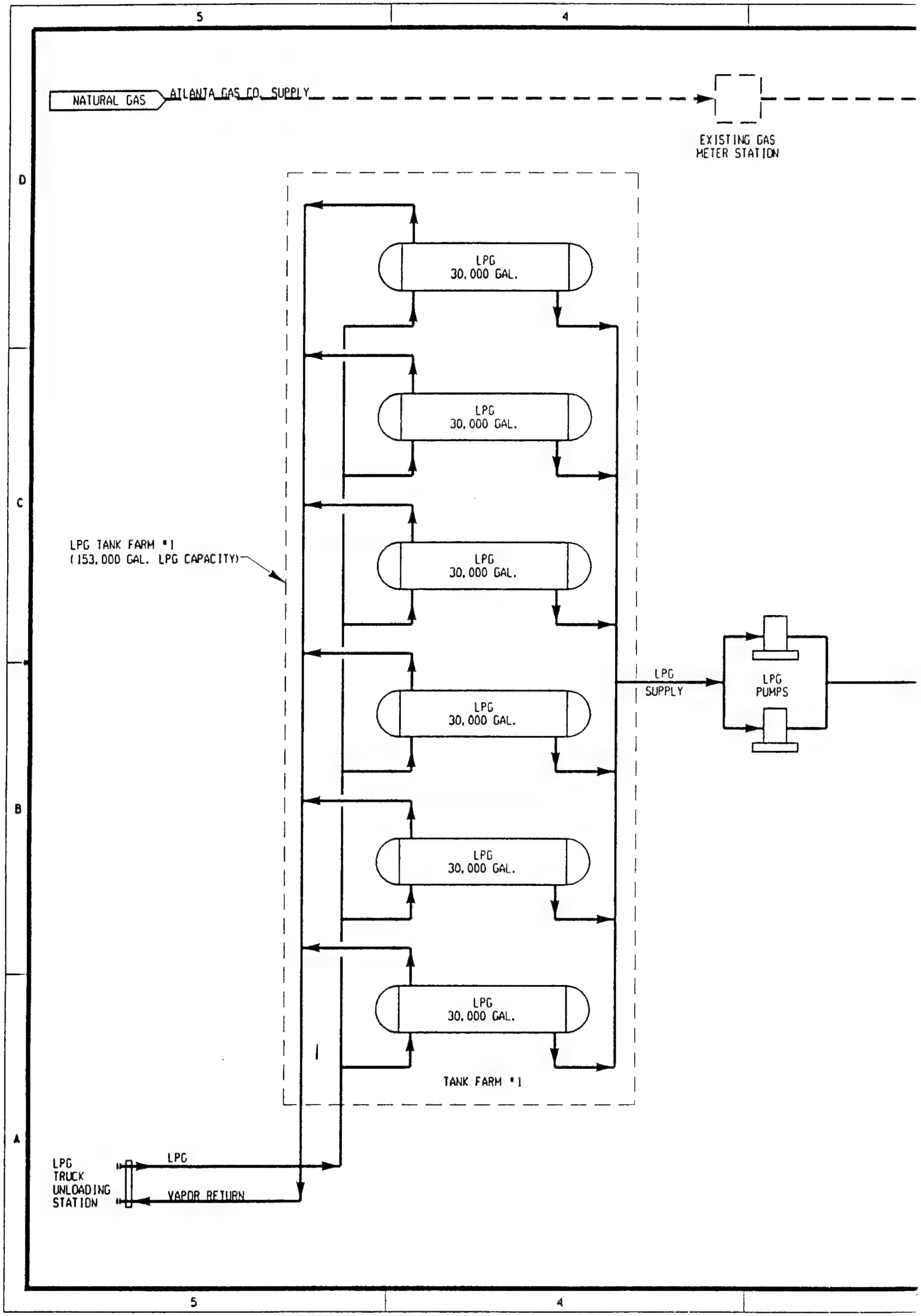
FORT GORDON
AUGUSTA, GEORGIA

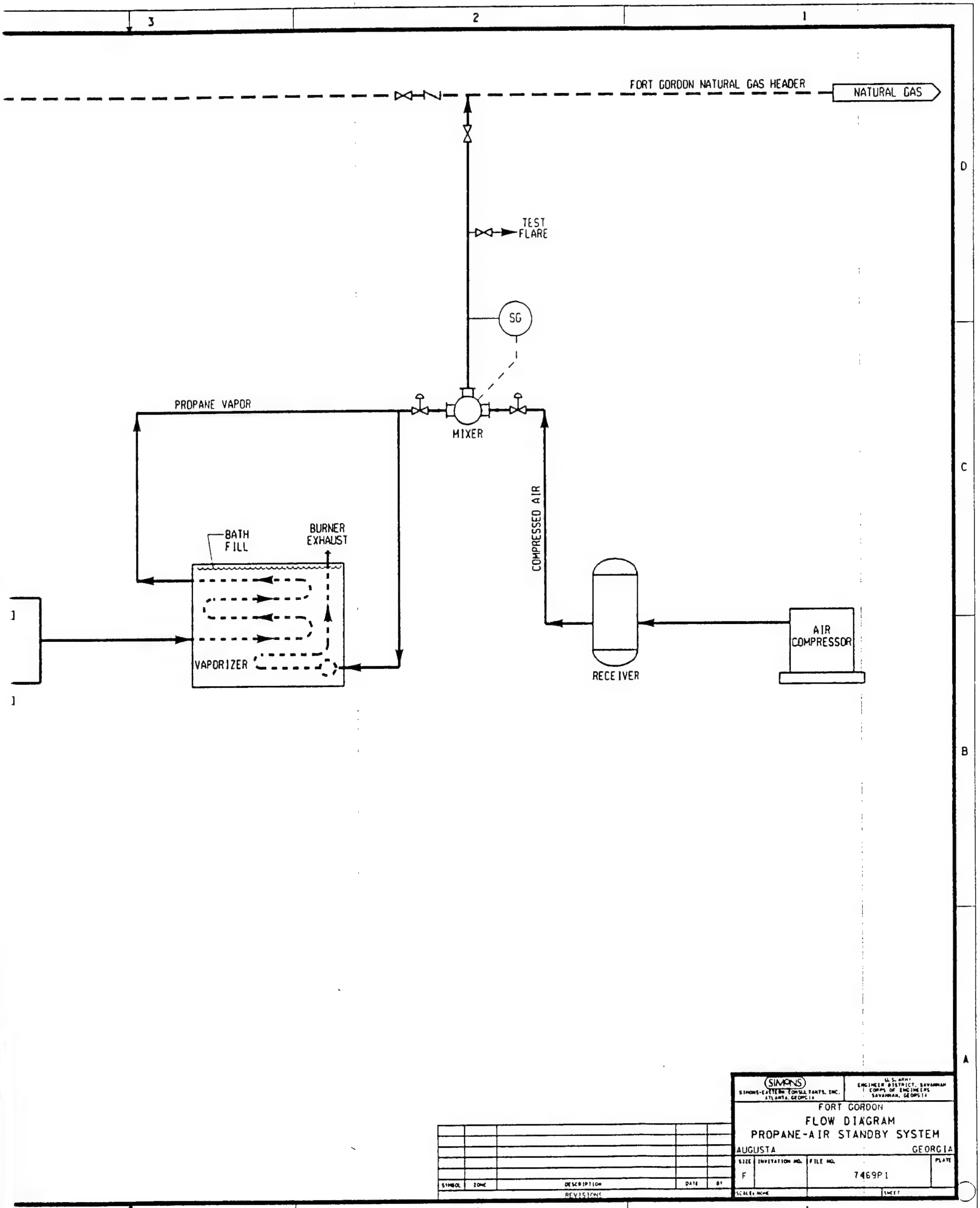
GAS

NEW CONDITIONS MAPS

DRAWING NO.	DATE	SHEET NO.
FILE NO.	AUGUST 18, 1992	6 OF 6

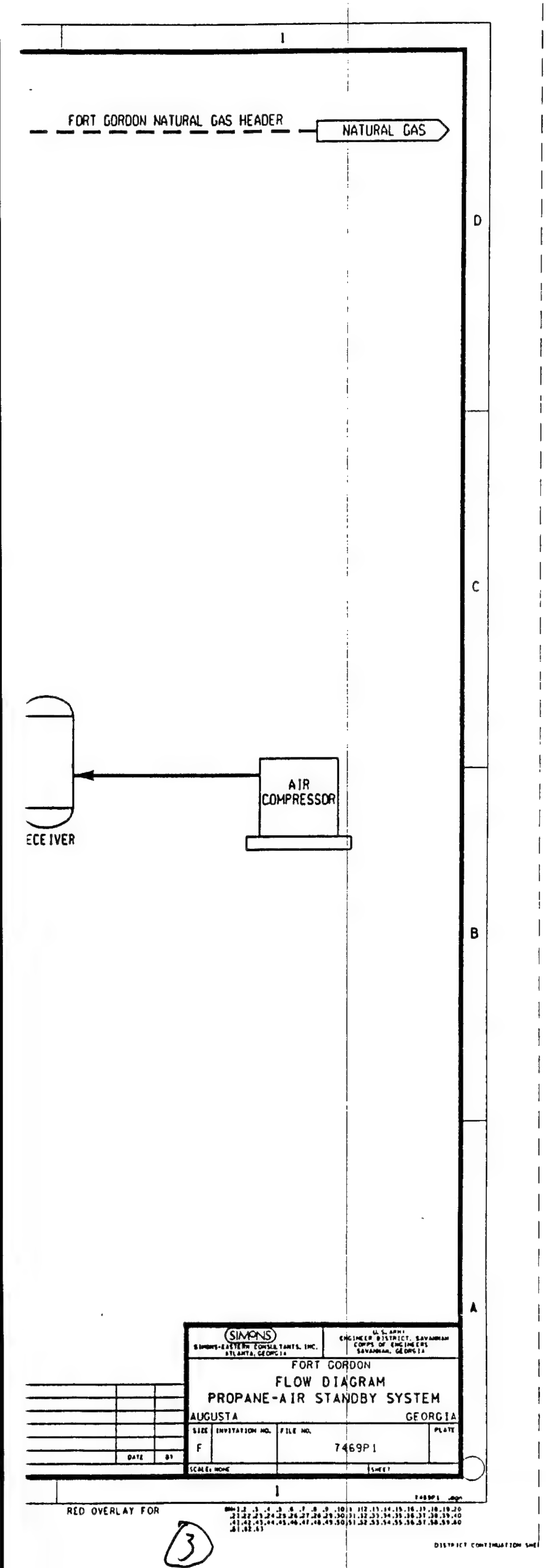
3

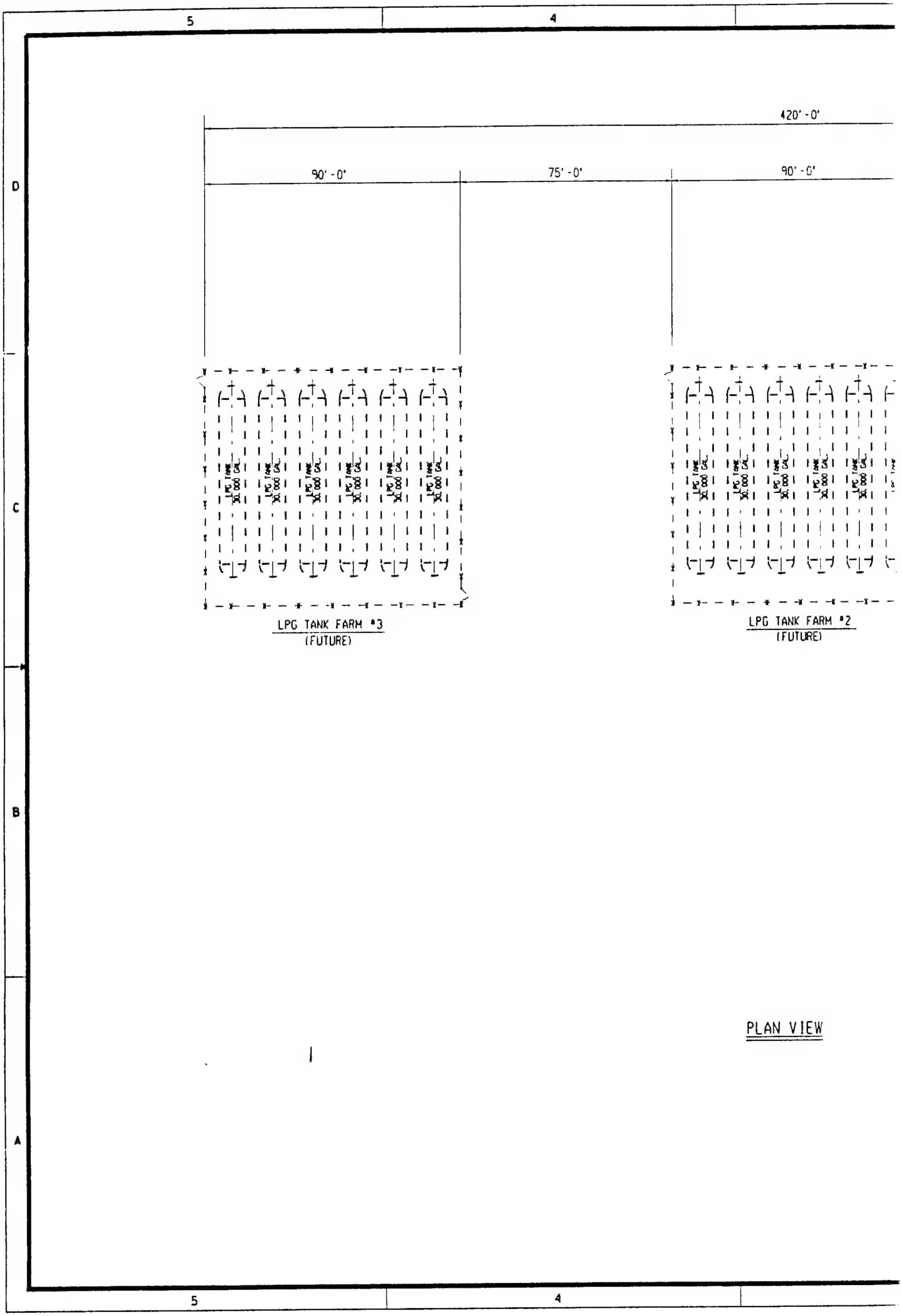

5
4
NATURAL GAS
ATLANTA GAS CO. SUPPLY
EXISTING GAS
METER STATION
D
C
B
A
LPG
30,000 GAL.
LPG
30,000 GAL.
LPG
30,000 GAL.
LPG
30,000 GAL.
LPG
30,000 GAL.
LPG
30,000 GAL.
LPG TANK FARM #1
(153,000 GAL. LPG CAPACITY)
LPG
SUPPLY
LPG
PUMPS
TANK FARM #1
LPG
TRUCK
UNLOADING
STATION
LPG
VAPOR RETURN
5
4
①



RED OVERLAY FOR

2

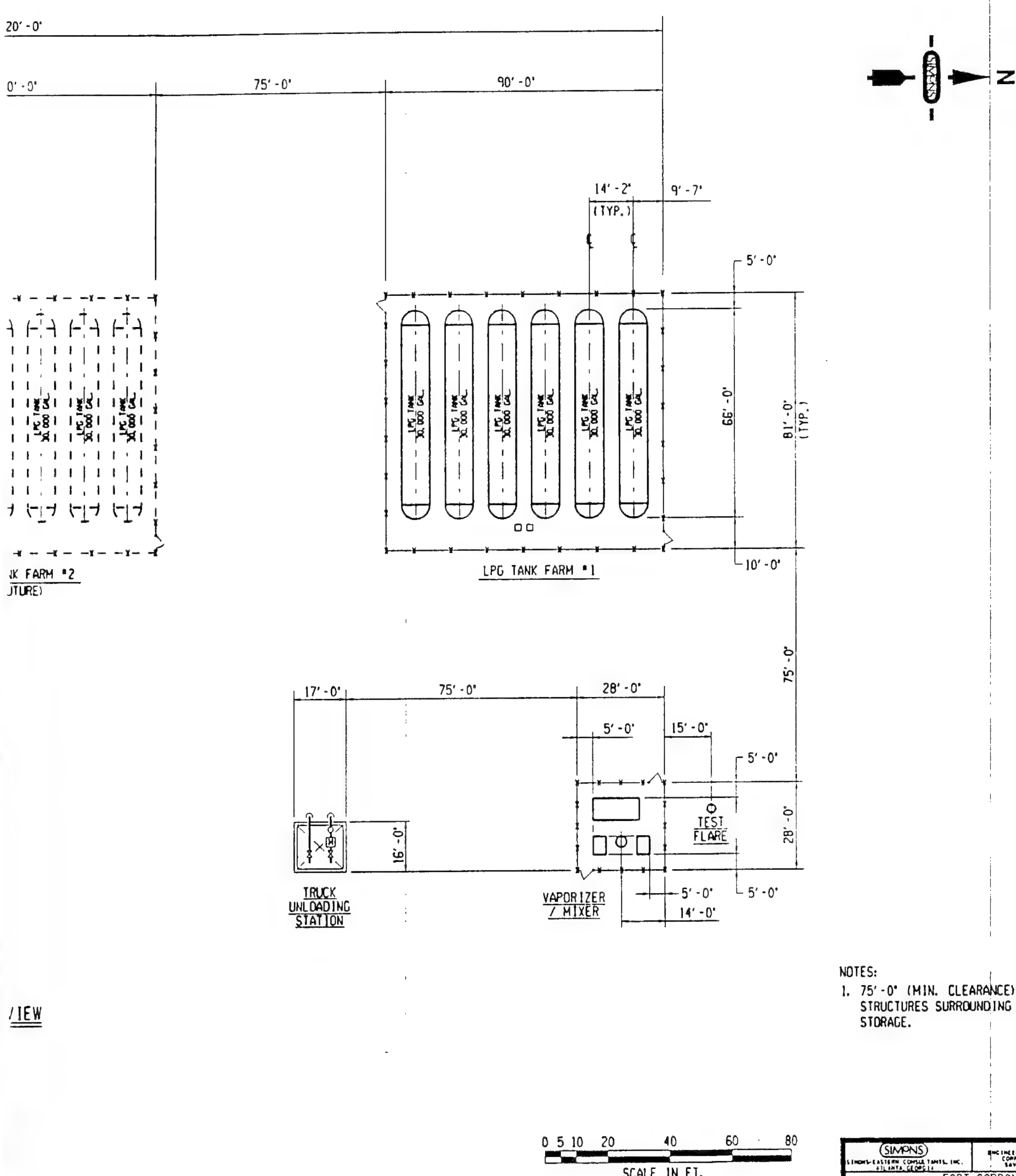

1
FORT GORDON NATURAL GAS HEADER
NATURAL GAS
D
C
AIR COMPRESSOR
ECEIVER
B
A
SIMONS
SIMONS-EASTERN CONSULTANTS, INC.
ATLANTA, GEORGIA
U.S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA
FORT GORDON
FLOW DIAGRAM
PROPANE-AIR STANDBY SYSTEM
AUGUSTA
GEORGIA
SIZE
INVITATION NO.
FILE NO.
PLATE
F
7469P1
SCALE: NONE
SHEET
DATE
BY
1
RED OVERLAY FOR
3
DISTRICT CONTINUATION SHEET



5
4
420' - 0'
90' - 0'
75' - 0'
90' - 0'
D
C
B
A
LPG TANK 30,000 GAL
LPG TANK FARM #3
(FUTURE)
LPG TANK FARM #2
(FUTURE)
5
4

PLAN VIEW

1



NOTES:

1. 75'-0" (MIN. CLEARANCE) TO OTHER STRUCTURES SURROUNDING LPG STORAGE.

SYMBOL	ZONE	DESCRIPTION	DATE	BY
		REVISIONS		

SIMONS
SIMONS-EASTERN CONSULTANTS, INC.
ATLANTA, GEORGIA

U.S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

FORT GORDON

GENERAL ARRANGEMENT
PROPANE-AIR STANDBY SYSTEM

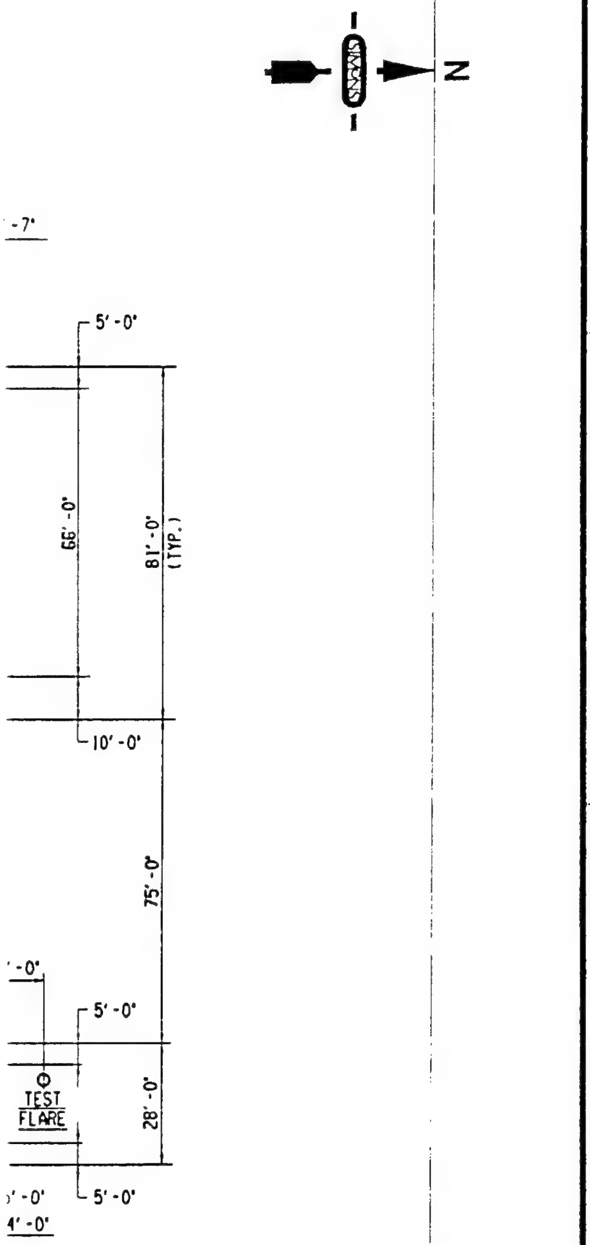
AUGUSTA GEORGIA

SIZE	INVITATION NO.	FILE NO.	PLATE
F		7A69P2	

RED OVERLAY FOR

DISTRICT CONFIRM.

2



NOTES:

1. 75'-0" (MIN. CLEARANCE) TO OTHER STRUCTURES SURROUNDING LPG STORAGE.

SIMONS
SIMONS-EASTERN CONSULTANTS, INC.
ATLANTA, GEORGIA

U.S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

FORT GORDON

GENERAL ARRANGEMENT

PROPANE-AIR STANDBY SYSTEM

AUGUSTA GEORGIA

SIZE	INVITATION NO.	FILE NO.	PLATE
F		7A69P2	

SCALE: SHEET

RED OVERLAY FOR

DISTRICT CONTINUATION SHEET

3

ESTIMATE DETAIL SUMMARY SHEET

For use of this form, see TM 5-800-2; the proponent agency is USACE.

PROJECT: PROPANE AIR STANDBY SYSTEM

ESTIMATOR: J.M. KISTNER

SHEET 1 OF 2

LOCATION: FT. GORDON, GEORGIA

CHECKED BY:

DATE PREPARED:

BID ITEM No.	Description	Quantity	Unit Meas	SUB-CONTRACT COST	PRIME CONTRACT COST	TOTAL DIRECT COST	OVERHEAD	SUB-TOTAL	PROFIT	TOTAL COST
	Total Sheet 2			—	1,039,703	1,039,703	incl	1,039,703	incl	1,039,702
	Other Costs Allowance									150,000
	(Site prep, power, etc)									
	Sub-Total									1,189,703
TOTAL	ESCALTED TO MID-POINT FY 95- MILCON INDEX 1.09									1,296,776

DA FORM 5417-R, Apr 85

COST ESTIMATE ANALYSIS

For use of this form, see TM 5-800-2; the proponent agency is USACE.

PROJECT	Propane Air Standby System
LOCATION	Ft. Gordon, Georgia
INVITATION/CONTRACTOR	
CODE (Check one)	☐ A ☐ B ☐ C ☒ OTHER Study
EFFECTIVE PRICING DATE	
DRAWING NO.	
ESTIMATOR	J.M. Kistner
DATE PREPARED	9-8-92
SHEET	2 OF 2 SHEETS
CHECKED BY	

TASK DESCRIPTION	QUANTITY: NO. OF UNITS	QUANTITY: UNIT MEAS	LABOR: MH UNIT	LABOR: TOTAL HRS	LABOR: UNIT PRICE	LABOR: COST	EQUIPMENT: UNIT PRICE	EQUIPMENT: COST	MATERIAL: UNIT PRICE	MATERIAL: COST	TOTAL	SHIPPING: UNIT WT	SHIPPING: TOTAL WT
Propane Storage -													
Sets of 6 tanks	1	sets					375K	375,000			375,000		
Vaporizer / Mixer		LS						450,000			450,000		
Truck Unloading		LS						10,000			10,000		
Initial Tank Fill													
w/ Propane	153 K	Gallon							.50	76,500	76,500		
Propane-Air Pipeline	2600	LF			21.30	55,380							
Bore & Sleeve	140	LF			163.02	22,823							
Tie-In & Block Valves		LS				10,000							
Fire Prot. / Water Spray								40,000					
TOTAL THIS SHEET						88,203		875,000		76,500	1,039,703		

DA FORM 5418-R, Apr 85

ESTIMATE DETAIL SUMMARY SHEET

For use of this form, see TM 5-800-2; the proponent agency is USACE.

PROJECT	ESTIMATOR	SHEET
AUXILIARY GAS METER	J.M. KISTNER	1 OF 2
LOCATION: FT. GORDON, GEORGIA	CHECKED BY	DATE PREPARED: 9-8-92

No.	Description	Quantity	Unit Meas	SUB-CONTRACT COST	PRIME CONTRACT COST	TOTAL DIRECT COST	OVERHEAD	SUB-TOTAL	PROFIT	TOTAL COST
	Total Sheet 2			15,000	—	15,000	1,500	16,500	incl.	16,500
	Estimating Contingency	20%								3,300
	Sub Total									19,800
TOTAL	ESCALATED TO MID-POINT FY95 - MILCON INDEX 1.09									21,582

DA FORM 5417-R, Apr 85

COST ESTIMATE ANALYSIS

For use of this form, see TM 5-800-2; the proponent agency is USACE.

PROJECT: AUXILIARY GAS METER	INVITATION/CONTRACTOR	EFFECTIVE PRICING DATE	DATE PREPARED: 9-8-92
LOCATION: FT. GORDON, GEORGIA	CODE (Check one): ☐ A ☐ B ☐ C ☒ OTHER STUDY	DRAWING NO.	SHEET 2 OF 2 SHEETS
		ESTIMATOR: J.M. KISTNER	CHECKED BY

TASK DESCRIPTION	QUANTITY		LABOR				EQUIPMENT		MATERIAL		TOTAL	SHIPPING	
	NO. OF UNITS	UNIT MEAS	MH UNIT	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST		UNIT WT	TOTAL WT
Mass flow Meter	1	ea			2,000	2,000	6,000	6,000	2,000	2,000	10,000		
Connection to EMCS		LS				2,000				3,000	5,000		
TOTAL THIS SHEET						4,000		6,000		5,000	15,000		

DA FORM 5418-R, Apr 85

ESTIMATE DETAIL SUMMARY SHEET

For use of this form, see TM 5-800-2; the proponent agency is USACE.

PROJECT: NEW GAS PIPELINE

ESTIMATOR: J.M. KISTNER

SHEET 1 OF 4

LOCATION: FT. GORDON, GEORGIA

CHECKED BY:

DATE PREPARED: 9-8-92

No.	BID ITEM Description	Quantity	Unit Meas	SUB-CONTRACT COST	PRIME CONTRACT COST	TOTAL DIRECT COST	OVERHEAD	SUB-TOTAL	PROFIT	TOTAL COST
							10% of Subcontract			
	Totals Sheet 2			18,000	705,112	723,112	1,800	724,912	incl.	724,912
	Totals Sheet 3			22,320	14,090	36,410	2,232	38,642	incl.	38,642
	Totals Sheet 4			70,000	22,500	92,500	7000	99,500	incl.	99,500
	Sub-Total			110,320	741,702	852,022	11,032	863,054		863,054
	Unspecified Costs	-20%								172,611
	Sub-Total									1,035,665
TOTAL	ESCALATED TO MID-POINT FY95 - MILCON INDEX 1.09									1,128,875

DA FORM 5417-R, Apr 85

COST ESTIMATE ANALYSIS

For use of this form, see TM 5-800-2; the proponent agency is USACE.

PROJECT	NEW GAS PIPELINE
LOCATION	FT GORDON, GEORGIA
INVITATION/CONTRACTOR	
CODE (Check one)	☐ A ☐ B ☐ C ☒ OTHER Study
EFFECTIVE PRICING DATE	
DRAWING NO.	
ESTIMATOR	J.M. Kistner
DATE PREPARED	9-8-92
SHEET	2 OF 4 SHEETS
CHECKED BY	

TASK DESCRIPTION	QUANTITY		L+E+M+ ~~LABOR~~ OH+P				EQUIPMENT		SUB ~~MATERIAL~~		TOTAL	SHIPPING	
	NO. OF UNITS	UNIT MEAS	MH UNIT	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST		UNIT WT	TOTAL WT
Install 8" pipeline	30,235	LF			21.30	644,006					644,006		
Bore & Sleeve - 12"	300	LF			163.02	48,906					48,906		
CUT & PATCH PAVEMENT	1800	SF							10.00	18,000	18,000		
Cut & Repair													
36" conc. pipe w/hdwl.	1	ea			1,100.00	1,100					1,100		
30" "	4	ea			800.00	3,200					3,200		
24" "	4	ea.			450.00	1,800					1,800		
18 "	5	ea.			300.00	1,500					1,500		
15 "	4	ea.			250.00	1,000					1,000		
Catch Basin	3	ea			1200.00	3,600					3600		
TOTAL THIS SHEET						705,112				18,000	723,112		

DA FORM 5418-R, Apr 85

COST ESTIMATE ANALYSIS

For use of this form, see TM 5-800-2; the proponent agency is USACE.

PROJECT: New Gas Pipeline

LOCATION: Ft. Gordon, Georgia

INVITATION/CONTRACTOR:

CODE (Check one): ☐ A ☐ B ☐ C ☒ OTHER Study

EFFECTIVE PRICING DATE:

DRAWING NO.:

ESTIMATOR: J.M. Kistner

DATE PREPARED: 9-8-92

SHEET 3 OF 4 SHEETS

CHECKED BY:

TASK DESCRIPTION	QUANTITY		L+E+M+ ~~LABOR~~ OH+P				EQUIPMENT		SUB ~~MATERIAL~~		TOTAL	SHIPPING	
	NO. OF UNITS	UNIT MEAS	MH UNIT	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST		UNIT WT	TOTAL WT
Cut & Repair													
48" CM w/ end	1	ea.			1400.00	1400					1,400		
24" "	2	ea.			400.00	800					800		
18" "	3	ea.			280.00	840					840		
12" "	1	ea.			200.00	200					200		
18" VC	1	ea			300.00	300					300		
10" VC	1	ea			250.00	250					250		
2" galv.	1	ea.			150.00	150					150		
Excavation, handling, rerouting, avoiding underground obstacles	29	EA			350.00	10,150					10,150		
Radiographic Insp. (assume 100%)	720	EA							31.00	22,320	22,320		
TOTAL THIS SHEET						14,090				22,320	36,410		

COST ESTIMATE ANALYSIS

For use of this form, see TM 5-800-2; the proponent agency is USACE.

PROJECT: New Gas Pipeline

LOCATION: Ft. Gordon, Georgia

INVITATION/CONTRACTOR:

CODE (Check one): ☐ A ☐ B ☐ C ☒ OTHER Study

EFFECTIVE PRICING DATE:

DRAWING NO.:

ESTIMATOR: J.M. Kistner

DATE PREPARED: 9-8-92

SHEET 4 OF 4 SHEETS

CHECKED BY:

TASK DESCRIPTION	QUANTITY		L+E+M + ~~LABOR~~ OH+P				SUB ~~EQUIPMENT~~		SUB ~~MATERIAL~~		TOTAL	SHIPPING	
	NO. OF UNITS	UNIT MEAS	MH UNIT	TOTAL HRS	UNIT PRICE	COST	UNIT PRICE	COST	UNIT PRICE	COST		UNIT WT	TOTAL WT
Furnish & Install	1	EA								10,000	10,000		
Rectifier on													
Existing 8" Main													
Remove Exist. Meter		LS			–	5,000					5,000		
Station @ Gate 5													
Tie-In @ Gate 5													
Bypass & Control Fittings		LS						30,000			30,000		
								from AGL					
Tie-In @ Gate 3													
Bypass & Control Fittings		LS						30,000			30,000		
Block & Check Valves	5	ea			3500	17,500		from AGL			17,500		
TOTAL THIS SHEET						22,500		60,000		10,000	92,500		

DA FORM 5418-R, Apr 85

CONSTRUCTION COST ESTIMATE WORKSHEET
For use of this form, see TM 5-800-2; the proponent agency is USACE.

DATE PREPARED: 7-25-92

SHEET 1 OF 6

PROJECT: L.P.G. STORAGE FACILITY STUDY

LOCATION: FT. GORDON, GEORGIA

PLAN NO.: MAP - Sht. 6 of 6

ESTIMATOR: J.M. KISTNER

CHECKED BY:

NEW GAS MAIN					Gas Main	Bore & Sleeve	Pavement	C/R	X/A
@ GATE 5									
1) REMOVE METER STATION				L.S	x				
2) Bore across Ave. Of States			12"ϕ	L.F.		80			
3) Tie-In @ exist 8" double block volves				L.S.	x				
4) West Side of Ave of States			8"	LF	2600				
5) Cut & Repair									
• Gas Station Drive			conc.	LF			230		
• 18" CM				ea.				3	
• 24" CM				ea.				1	
• 12" CM								1	
• Catch. Basin								3	
6) Cross & Avoid									
• 4" sanit.			C.I						1
• ? water			C.I						1
• 42" C (deep)									~~1~~
• 36" C									1
• 24" CI									1
7) South Side Of North Range Road			8"	LF	1050				
• 90° turn					x				

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CONSTRUCTION COST ESTIMATE WORKSHEET

For use of this form, see TM 5-800-2; the proponent agency is USACE.

DATE PREPARED: 7-25-92

SHEET 2 **OF** 6

PROJECT: LPG STORAGE FACILITY STUDY

LOCATION: FT. GORDON, GEORGIA

PLAN NO.: MAP SHT 5 of 6

ESTIMATOR: J.M. KISTNER

CHECKED BY:

NEW GAS MAIN

	Size	Unit	Gas Main	Bore & Sleeve	Pavement	C/R	X/A
1) South Side of North Range Rd. to Mirror Lake	8"	LF	5150				
2) Cut & Repair							
• 15" conc		ea				4	
• 24" CM		ea.				1	
3) Cross @ Mirror Lake 48"x24" CM		ea.					2
4) South Side of North Range Road to Range Road	8"	LF	2200				
• Bore across	12"	LF		40			
• Cut & Repair - 18" VC		ea				1	
5) South Side of North Range Rd.	8"	LF	5500				
6) Cut & Patch Sewage Plant Road - asphalt		LF			20		
7) Cut & Repair							
• 24" C						3	
• 30" C						1	
• 18" C						1	

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CONSTRUCTION COST ESTIMATE WORKSHEET
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DATE PREPARED: 7-25-92

SHEET 3 OF 6

PROJECT: LPG STORAGE FACILITY STUDY

LOCATION: FT. GORDON, GEORGIA

PLAN NO.: MAP Sht 5 of 6

ESTIMATOR: J.M. Kistner

CHECKED BY:

NEW GAS MAIN

							C/R	X/A
8) Cross & Avoid								
• 60" CM			ea.					1
• 15" VC sanit.			ea.					1
• 6" VC sanit			ea					1
• Manhole (15" VC)			ea.					1
• 6" CI water			ea					1
9) Run Parallel w/			LF					1100 LF
6" CI water								

DA FORM 5421-R, Apr 85

CONSTRUCTION COST ESTIMATE WORKSHEET For use of this form, see TM 5-800-2; the proponent agency is USACE.	DATE PREPARED 7-25-92	SHEET 4 OF 6
PROJECT LPG STORAGE FACILITY STUDY		
LOCATION FT. GORDON, GEORGIA		
PLAN NO. Map Sht. 4 of 6	ESTIMATOR J. M. Kistner	CHECKED BY

NEW GAS MAIN			Gas Main	Bore & Sleeve	Pavement	C/R	X/A
1) South Side of North Range Road to 12th Street	8"	LF	4450				
• 3 lateral bends			x				
2) Cross & Avoid							
• 30" C							2
• 24" C							2
• Manhole (24" C)(21" C)							2
• 6" CI water							1
• 21" C (sanit)							1
• 21" VC (sanit)							1
3) Run parallel w/ 6" CI water		LF					2050 LF
4) West Side of 12th Street	8"	LF	2695				
• 45° bend			x				
• 90° bend			x				
• Bore N. Range	12"	LF		40			
5) Cut & Repair							
• Pavement (2 places)		LF			60		
• 18" C						1	
6) Cross & Avoid							
• 24" C							1
• 30" C							1
• 48" CM							1
• 10" VC							2
• 6" CI							2

CONSTRUCTION COST ESTIMATE WORKSHEET
For use of this form, see TM 5-800-2; the proponent agency is USACE.

DATE PREPARED: 7-25-92 | SHEET 5 OF 6

PROJECT: LPG STORAGE FACILITY STUDY

LOCATION: FT. GORDON, GEORGIA

PLAN NO.: Map Sht. 1 of 6 | ESTIMATOR: J.M. Kistner | CHECKED BY:

NEW GAS MAIN

			Gas Main	Bore & Sleeve	Pavement	C/R	X/A
1) South Side Of							
3rd Ave. to 10th	8"	LF	75				
• 45° bend							
• 90° bend							
2) Cut & Repair							
• 30" C						2	
• 24" C						1	
3) West side of 10th							
Street & 9th Street	8"	LF	3855				
to Chamberlin							
4) Cut & patch roads	5	ea			100		
(asphalt)	@ 20	ft					
5) Cut & Repair							
• 18" C						3	
6) Cross & Avoid							
• 36" C						1	
• 30" C						1	
• 48" CM						1	
• 10" VC (sanit)						1	
• 2" GS - water						1	
7) North Side of							
Chamberlin to 10th St	8"	LF	60				

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CONSTRUCTION COST ESTIMATE WORKSHEET For use of this form, see TM 5-800-2; the proponent agency is USACE.	DATE PREPARED 7-25-92	SHEET 6 OF 6

PROJECT: LPG STORAGE FACILITY STUDY

LOCATION: FT. GORDON, GEORGIA

PLAN NO.	ESTIMATOR	CHECKED BY
Map. Sht 1 of 6	J.M. KISTNER	

NEW GAS LINE				Gas Main	Bore & Sleeve	Pavement C/R		X/A
8) West side of 10th								
St to 12th Ave	8"	LF		1600				
9) Cross Railroads - 1 track					20			
3 track					60			
3 track					60			
10) Cross & Avoid								
30" C								1
24" C								1
6" CI water								
11) Cut & Patch								
Pavement - asphalt		LF				40		
12) West to tie in								
near exist meter	8"	LF		1000				
13) Move meter station		LS		x				
				=	=	=		
Total Pipe				30,235				
Total Bore					300			
Total Pavement						450 LF		

DA FORM 5421-R, Apr 85

☆ U.S. GOVERNMENT PRINTING OFFICE : 1985 O - 476-843

CONSTRUCTION COST ESTIMATE WORKSHEET
For use of this form, see TM 5-800-2; the proponent agency is USACE.

DATE PREPARED: 7-30-92 | SHEET 1 OF

PROJECT: LPG STORAGE SYSTEM STUDY

LOCATION: FT. GORDON, GEORGIA

PLAN NO.: | ESTIMATOR: J.M. KISTNER | CHECKED BY:

PIPELINE CONSTRUCTION COSTS

8" Pipeline			
Pipe, Sch. 40 Smls	LF	$ 11.15	Quote from Ferguson
Coating		2.63	Richardson 15-43
Install in trench		2.51	"
Joints – weld		1.50	@ 62.93 per joint (42')
– coat / wrap		.26	@ 10.91 ea
Trench		.48	18" wide x 4 ft @ 2.17/CY
Backfill & compact		2.83	@ 12.72/CY
		$ 21.36	
GA. NATURAL GAS CO. USES $ 21.29 for budget			
12" Bore & Sleeve			
Pipe, 12"	LF	$ 21.95	Quote from Ferguson
Bore & Install		110.00	Means – factored
Excav & Backfill		31.07	4' dp x 12' wide x (1.5 x length)
		163.02	
Cut & Repair			
36" conc. pipe	LF	30.00	
Exc. & Backfill		10.00	
Headwall		30.00	assume 10' length avg
Install Pipe		40.00	
	LF	110.00	x 10 LF = 1100.00
30"		80.00	= 800.00
24"		45.00	= 450.00
18"		30.00	= 300.00
15"		25.00	= 250.00

SIMONS

Appendix G - Calculations

U. S. Army Engineer District, Savannah
Ft. Gordon LPG Study
Final Submittal

Index

HEAT LOSS ESTIMATES FOR SIMILAR STRUCTURES - HOUSING
FORT GORDON, GEORGIA

	3 BR COL 1/1/3	EM1 2/1/3	EM2 2/1/4	1EM2(SP) 2/2/4	1EM1(SP) 4/2/3	1EM2(SP) 4/2/4	1EM1(SP) 6/2/4	ICGO1 8/2/3
Design Basis								
Structure Description								
Glass	DP	DP	DP	DP	DP	DP	DP	DP
Walls	SIDING	SIDING	SIDING	SIDING	SIDING	SIDING	SIDING	SIDING
Roof	SHINGLE	SHINGLE	SHINGLE	SHINGLE	SHINGLE	SHINGLE	SHINGLE	SHINGLE
Heat Transfer 'U' Value								
Glass	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
Walls	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Roof	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Heat Transfer 'R' Value (Calc)								
Glass	1.64	1.64	1.64	1.64	1.64	1.64	1.64	1.64
Walls	2.22	2.22	2.22	2.22	2.22	2.22	2.22	2.22
Roof	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Temperatures (Deg F)								
Outdoor	20	20	20	20	20	20	20	20
Indoor	78	78	78	78	78	78	78	78
Infiltration Rate (AC/Hr)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Heat Loss Calculation								
Estimated Building Area (SF)								
Glass	242	256	278	256	512	512	4,173	1,024
Walls	1,269	1,567	1,748	2,015	3,103	3,103	1,045	5,179
Roof	1,768	2,400	2,758	1,218	2,436	2,436	1,298	4,872
Bldg SF	1,768	2,400	2,758	2,370	4,740	4,740	1,298	9,480
Heat loss - Building (BTUH)								
Glass	8,562	9,057	9,836	9,057	18,115	18,115	147,641	36,229
Walls	33,121	40,899	45,623	52,592	80,988	80,988	27,275	135,172
Roof	20,509	27,840	31,993	14,129	28,258	28,258	15,057	56,515
Heat Loss - Infiltration (BTUH)	8,204	11,136	12,797	10,997	21,994	21,994	6,023	43,987
Total Building Heat Loss (BTUH)	70,000	89,000	100,000	87,000	149,000	149,000	196,000	272,000

HEAT LOSS ESTIMATES - BUILDINGS
FORT GORDON, GEORGIA

18400 EM CLB	18402 NCO CLB	21608 POOL	21709 MESS	24414 MESS	29300 AUTO	35402 BK	39005 BREMS	39007 BREMS	39105 BREMS	39111 BREMS	39211 BREMS	40201 BREMS
SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP	SP
MASONRY	MASONRY	MASONRY	MASONRY	MASONRY	MASONRY	MASONRY	MASONRY	MASONRY	MASONRY	MASONRY	MASONRY	MASONRY
BUILTUP	BUILTUP	BUILTUP	BUILTUP	BUILTUP	BUILTUP	BUILTUP	BUILTUP	BUILTUP	BUILTUP	BUILTUP	BUILTUP	BUILTUP
1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13
0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
5.88	5.88	5.88	5.88	5.88	5.88	5.88	5.88	5.88	5.88	5.88	5.88	5.88
4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76	4.76
20	20	20	20	20	20	20	20	20	20	20	20	20
72	72	72	72	72	72	72	72	72	72	72	72	72
3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
898	760	1,092	1,320	859	966	680	475	391	403	361	355	403
6,587	5,576	8,013	9,684	6,303	7,989	1,588	6,283	2,515	3,620	2,408	2,748	2,476
18,824	17,408	23,271	11,320	20,205	18,623	2,929	6,419	3,039	4,936	2,286	3,914	3,200
32,267	17,408	23,271	11,320	20,205	18,623	2,929	6,419	3,039	4,936	2,286	3,914	3,200
52,766	44,658	64,166	77,563	50,475	56,762	39,957	27,911	22,975	23,680	21,212	20,860	23,680
58,229	49,292	70,835	85,607	55,719	70,623	14,038	55,542	22,233	32,001	21,287	24,292	21,888
205,558	190,095	254,119	123,614	220,639	203,363	31,985	70,095	33,186	53,901	24,963	42,741	34,944
805,384	434,504	580,844	282,547	504,317	464,830	73,108	160,218	75,853	123,203	57,059	97,693	79,872
1,122,000	719,000	970,000	569,000	831,000	796,000	159,000	314,000	154,000	233,000	125,000	186,000	160,000

SIMONS

CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT OVERALL Heat Transfer Coeff. SHEET NO. 1 OF 4 JOB NO. 7469 B

BY GWS DATE ______ CHKD. BY ______ DATE 7/30/92

Assumptions

HOUSING — REF

A) GLASS 0.61 BTU/HR·SF·°F — p. 2-184

Basis: Double Pane, 1/4" Air Gap

B) WALLS 0.12 BTU/HR·SF·°F — p 2-163 AND p 2 of 2 these CALCS

Basis: Gyp Board, Plywood, 2" BATT INSUL.

c) ROOF 0.20 BTU/HR·SF·°F

Basis: FRAMED

BUILDINGS

A) GLASS 1.13 BTU/HR·SF·°F — p 2-184

Basis: Single PANE

B) WALLS: .17 — p. 2-163

Basis: MASONRY, Block, Gyp Board

C) ROOF .21 — p. 2-166

Basis: BUILT UP

REFERENCE: Handbook of Air Conditioning Heating + Ventalatin THIRD EDITION

SIMONS

CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT Housing - Heat Trans. Coeff (walls) SHEET NO. 2 OF 4 JOB NO. 7469B

BY GWS DATE CHKD. BY DATE 7/27/92

Purpose: Determine overall heat transfer coeff ("U" factor) of a typical family housing wall section

Basis:

1/2" Gypsum Board
2" Insulation
1 1/2" Airgap
1/2" Plywood
1/2" shingles (assume plywood)

Ref: Housing Dwg.
Handbook of Air Cond, Heating + Ventilating

Calculations:

(1) Equations: $U_T = \dfrac{1}{R_1 + R_2 + R_3 + R_4 + R_5}$

$R = 1/C$

(2)

	t	K	C	R
1 - Gypsum Board	1/2"		2.22	.45
2 - Insulation	2"		.143	7
3 - Air	1 1/2			.80
4 - Plywood	1/2		1.6	.625
5 - Plywood	1/2		1.6	.625
			$R_T =$	8.25

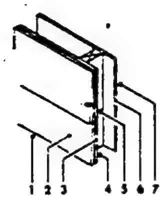
(3) Overall 'U-Factor' $= \dfrac{1}{8.25} = .12 \dfrac{BTU}{HR\,SF\,°F}$

Sheet No. 3 of 4

Table 4A Coefficients of Transmission (U) of Frame Walls

These coefficients are expressed in Btu per (hour) (square foot) (degree Fahrenheit) difference in temperature between the air on the two sides), and are based on an outside wind velocity of 15 mph

Replace Air Space with 3.5-in. R-11 Blanket Insulation (New Item 4)



Construction	1 Resistance (R) Between Framing	1 At Framing	2 Between Framing	2 At Framing
1. Outside surface (15 mph wind)	0.17	0.17	0.17	0.17
2. Siding, wood, 0.5 in. × 8 in. lapped (average)	0.81	0.81	0.81	0.81
3. Sheathing, 0.5-in. asphalt impregnated	1.32	1.32	1.32	1.32
4. Nonreflective air space, 3.5 in. (50 F mean; 10 deg F temperature difference)	1.01	—	11.00	—
5. Nominal 2-in. × 4-in. wood stud	—	4.38	—	4.38
6. Gypsum wallboard, 0.5 in.	0.45	0.45	0.45	0.45
7. Inside surface (still air)	0.68	0.68	0.68	0.68
Total Thermal Resistance (R)	R_i=4.44	R_s=7.81	R_i=14.43	R_s=7.81

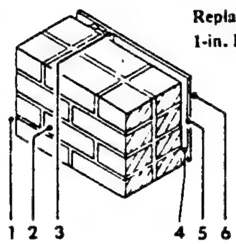
Construction No. 1: U_i = 1/4.44=0.225; U_s=1/7.81 =0.128. With 20% framing (typical of 2-in. × 4-in. studs @ 16-in. o.c.), U_{av} = 0.8 (0.225) + 0.2 (0.128) = 0.206 (See Eq 9)

Construction No. 2: U_i = 1/14.43 = 0.069; U_s = 0.128. With framing unchanged, U_{av} = 0.8(0.069) + 0.2(0.128) = 0.081

Table 4B Coefficients of Transmission (U) of Solid Masonry Walls

Coefficients are expressed in Btu per (hour) (square foot) (degree Fahrenheit difference in temperature between the air on the two sides), and are based on an outside wind velocity of 15 mph

Replace Furring Strips and Air Space with 1-in. Extruded Polystyrene (New Item 4)



Construction	1 Resistance (R) Between Furring	1 At Furring	2
1. Outside surface (15 mph wind)	0.17	0.17	0.17
2. Common brick, 8 in.	1.60	1.60	1.60
3. Nominal 1-in. ×3-in. vertical furring	—	0.94	—
4. Nonreflective air space, 0.75 in. (50 F mean; 10 deg F temperature difference)	1.01	—	5.00
5. Gypsum wallboard, 0.5 in.	0.45	0.45	0.45
6. Inside surface (still air)	0.68	0.68	0.68
Total Thermal Resistance (R)	R_i = 3.91	R_s = 3.84	R_i = 7.90 = R_s

Construction No. 1: U_i = 1/3.91=0.256; U_s=1/3.84=0.260. With 20% framing (typical of 1-in. × 3-in. vertical furring on masonry @ 16-in. o.c.) U_{av} = 0.8 (0.256) + 0.2 (0.260) = 0.257

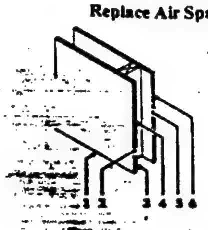
Construction No. 2: U_i = U_s = U_{av} = 1/7.90 = 0.127

Table 4C Coefficients of Transmission (U) of Frame Partitions or Interior Walls

Coefficients are expressed in Btu per (hour) (square foot) (degree Fahrenheit difference in temperature between the air on the two sides), and are based on still air (no wind) conditions on both sides

Replace Air Space with 3.5-in. R-11 Blanket Insulation (New Item 3)

HOUSING WALLS (Typ. CALC)



Construction	1 Resistance (R) Between Framing	1 At Framing	2 Between Framing	2 At Framing
1. Inside surface (still air)	0.68	0.68	0.68	0.68
2. Gypsum wallboard, 0.5 in.	0.45	0.45	0.45	0.45
3. Nonreflective air space, 3.5 in. (50 F mean; 10 deg F temperature difference)	1.01	—	11.00	—
4. Nominal 2-in. × 4-in. wood stud	—	4.38	—	4.38
5. Gypsum wallboard0.5 in.	0.45	0.45	0.45	0.45
6. Inside surface (still air)	0.68	0.68	0.68	0.68
Total Thermal Resistance (R)	R_i= 3.27	R_s= 6.64	R_i=13.26	R_s= 6.64

Construction No. 1: U_i= 1/3.27 = 0.306; U_s= 1/6.64 = 0.151. With 10% framing (typical of 2-in. × 4-in. studs @ 24-in. o.c.), U_{av}= 0.9 (0.306) + 0.1 (0.151) = 0.290

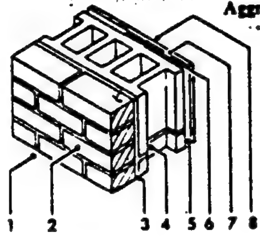
Construction No. 2: U_i = 1/13.26 = 0.075,U_s = 1/6.64 = 0.151. With framing unchanged, U_{av} = 0.9(0.075) + 0.1(0.151) = 0.083

Table 4D Coefficients of Transmission (U) of Masonry Walls

Coefficients are expressed in Btu per (hour) (square foot) (degree Fahrenheit difference in temperature between the air on the two sides), and are based on an outside wind velocity of 15 mph

Replace Cinder Aggregate Block with 6-in. Light-weight Aggregate Block with Cores Filled (New Item 4)

BUILDING WALLS



Construction	1 Resistance (R) Between Furring	1 At Furring	2 Between Furring	2 At Furring
1. Outside surface (15 mph wind)	0.17	0.17	0.17	0.17
2. Face brick, 4 in.	0.44	0.44	0.44	0.44
3. Cement mortar, 0.5 in.	0.10	0.10	0.10	0.10
4. Concrete block, cinder aggregate, 8 in.	1.72	1.72	2.99	2.99
5. Reflective air space, 0.75 in. (50 F mean; 30 deg F temperature difference)	2.77	—	2.77	—
6. Nominal 1-in. × 3-in. vertical furring	—	0.94	—	0.94
7. Gypsum wallboard, 0.5 in., foil backed	0.45	0.45	0.45	0.45
8. Inside surface (still air)	0.68	0.68	0.68	0.68
Total Thermal Resistance (R)	R_i= 6.33	R_s= 4.50	R_i= 7.60	R_s= 5.77

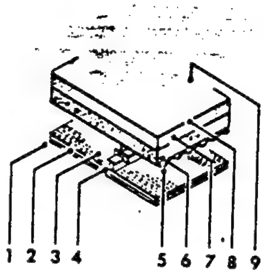
* Construction No. 1: U_i= 1/6.33 = 0.158; U_s = 1/4.50 = 0.222. With 20% framing (typical of 1-in. × 3-in. vertical furring on masonry @ 16-in. o.c.), U_{av} = 0.8 (0.158) + 0.2 (0.222) = 0.171

Construction No. 2: U_i = 1/7.60 = 0.132,U_s = 1/5.77 = 0.173. With framing unchanged, U_{av} = 0.8(0.132) + 0.2(0.173) = 1.40

Table 4H Coefficients of Transmission (*U*) of Flat Masonry Roofs with Built-up Roofing, with and without Suspended Ceilings[a] (Winter Conditions, Upward Flow)

These Coefficients are expressed in Btu per (hour) (square foot) (degree Fahrenheit difference in temperature between the air on the two sides), and are based upon an outside wind velocity of 15 mph

BUILDING ROOF



Add Rigid Roof Deck Insulation, $C = 0.24$ ($R = 1/C$) (New Item 7) Construction (Heat Flow Up)	1	2
1. Inside surface (still air)	0.61	0.61
1. Metal lath and lightweight aggregate plaster, 0.75 in.	0.47	0.47
3. Nonreflective air space, greater than 3.5 in. (50 F mean; 10 deg F temperature difference)	0.93*	0.93*
4. Metal ceiling suspension system with metal hanger rods	0**	0**
5. Corrugated metal deck	0	0
6. Concrete slab, lightweight aggregate, 2 in.	2.22	2.22
7. Rigid roof deck insulation (none)	—	4.17
8. Built-up roofing, 0.375 in.	0.33	0.33
9. Outside surface (15 mph wind)	0.17	0.17
Total Thermal Resistance (R)	4.73	8.90

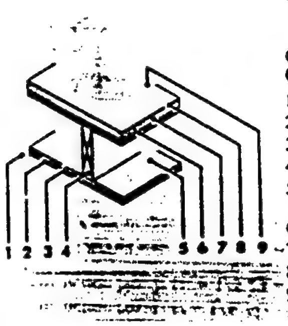
Construction No. 1: $U_{av} = 1/4.73 = 0.211$
Construction No. 2: $U_{av} = 1/8.90 = 0.112$

[a] To adjust *U* values for the effect of added insulation between framing members, see Table 5 or 6.
*Use largest air space (3.5 in.) value shown in Table 2.
**Area of hanger rods is negligible in relation to ceiling area.

Table 4I Coefficients of Transmission (*U*) of Wood Construction Flat Roofs and Ceilings (Winter Conditions, Upward Flow)

Coefficients are expressed in Btu per (hour) (square foot) (degree Fahrenheit difference in temperature between the air on the two sides), and are based upon an outside wind velocity of 15 mph

Replace Roof Deck Insulation and 7.25-in. Air Space with 6-in. R-19 Blanket Insulation and 1.25-in. Air Space (New Items 5 and 7)



Construction (Heat Flow Up)	1 Resistance (R) Between Joists	 At Joists	2 Between Joists	 At Joists
1. Inside surface (still air)	0.61	0.61	0.61	0.61
2. Acoustical tile, fiberboard, glued, 0.5 in.	1.25	1.25	1.25	1.25
3. Gypsum wallboard, 0.5 in.	0.45	0.45	0.45	0.45
4. Nominal 2-in. × 8-in. ceiling joists	—	9.06	—	9.06
5. Nonreflective air space, 7.25 in. (50 F mean; 10 deg F temperature difference)	0.93*	—	1.05**	—
6. Plywood deck, 0.625 in.	0.78	0.78	0.78	0.78
7. Rigid roof deck insulation, $c = 0.72$, ($R = 1/C$)	1.39	1.39	19.00	—
8. Built-up roof	0.33	0.33	0.33	0.33
9. Outside surface (15 mph wind)	0.17	0.17	0.17	0.17
Total Thermal Resistance (R)	R_i=5.91	R_s=14.04	R_i=23.64	R_s=12.65

Construction No. 1 $U_i = 1/5.91 = 0.169$; $U_s = 1/14.04 = 0.071$. With 10% framing (typical of 2-in. joists @ 16-in. o.c.), $U_{av} = 0.9 (0.169) + 0.1 (0.071) = 0.159$

Construction No. 2 $U_i = 1/23.64 = 0.042$; $U_s = 1/12.65 = 0.079$. With framing unchanged, $U_{av} = 0.9 (0.042) + 0.1 (0.079) = 0.046$

*Use largest air space (3.5 in.) value shown in Table 2.
**Interpolated value (0 F mean; 10 deg F temperature difference).

SIMONS

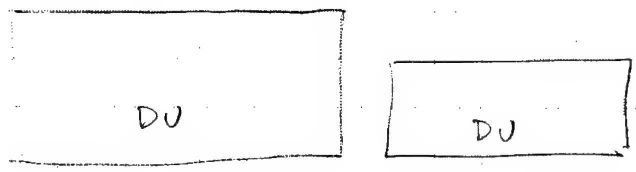
CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT Housing - Take offs of TYP Areas SHEET NO. 1 OF 9 JOB NO. 7469B

BY LLS DATE 7/24/92 CHKD. BY ________ DATE ________

Colonel - 3BR



Plan Elev.

TYPE - 1 Story 3BR Single - 1 DU
WALLS - 1512 - 242.41 = 1269.59
GLASS - 242.41
ROOF - 1768
BLDG. 1768

WALLS

33.5 x 8 x 2 = 536
61 x 8 x 2 = 976
1512

GLASS

2 @ 15.34 = 30.68
2 @ 22.36 = 44.72
3 @ 15.34 = 46.02
1 @ 18.47 = 18.47
1 @ 36.94 = 36.94
2 @ 15.34 = 30.68
1 @ 4.22 = 4.22
2 @ 15.34 = 30.68
242.41

FLOOR PLAN

29 x 24 = 696
(61 - 29) x 33.5 = 1072
1768

SIMONS

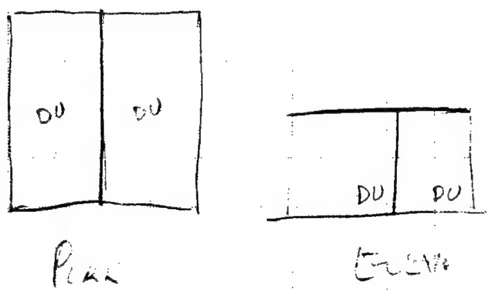
CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT Housing - Takeoffs of Typ Areas SHEET NO. 2 OF 9 JOB NO. 7469B

BY LLS DATE 7/24/92 CHKD. BY ______ DATE ______

EM-1



TYPE 1 Story Duplex - 2 DU
WALL S.F. = 1823.84 - 256.02 = 1567.82
GLASS = 256.02 FT²
ROOF = 2400 FT²
BLDG FLR = 2400 FT²

WALLS

55.66 × 8 × 2 = 1370.56
28.33 × 8 × 2 = 453.28
1823.84

WINDOWS

1 @ 22.36 = 22.36 × 2 =
3 @ 15.34 = 46.02 × 2 =
1 @ 18.47 = 18.47 × 2 =
1 @ 4.22 = 4.22 × 2 =

DOOR

1 @ 36.94 = 36.94 × 2 =
128.01 × 2 = 256.02

SIMONS

CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT Housing - Take offs of Typ Areas SHEET NO. 3 OF 9 JOB NO. 746913

BY LLS DATE 7/24/92 CHKD. BY DATE

EM2

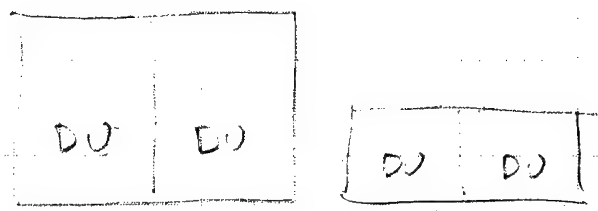
TYPE 1 Story + BG Duplex - 2 DU

WALLS - 2026.56 - 278.26 = 1748.30

GLASS - 278.26

ROOF - 2758

BLDG. FLOOR - 2758



Plan   Elev.

WALLS

98.33 x 8 x 2 = 1573.28
28.33 x 8 x 2 = 453.28
2026.56

GLASS

1 @ 22.36 x 2 = 44.72
4 @ 15.34 x 2 = 122.72
1 @ 18.47 x 2 = 36.94
1 @ 36.94 x 2 = 73.88
278.26

SIMONS

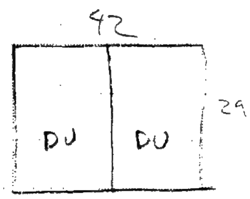
CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

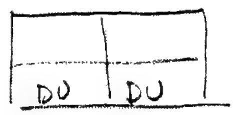
SUBJECT Housing - Take offs of Typ Areas SHEET NO. 4 OF ____ JOB NO. 7469 B

BY LLS DATE 7/24/92 CHKD. BY ____ DATE ____

1 EM2 (SP) 2 DU



PLAN



ELEV.

TYPE - 2 STORY 4 BR DUPLEX - 2 DU
WALLS - 2272 - 256.02 = 2015.98
GLASS - 256.02
ROOF - 1218
BLDG. FLOOR - 2370

WALLS

$21 \times 2 \times 8 \times 2 \times 2 = 1344$
$29 \times 8 \times 2 \times 2 = 928$
2272

GLASS

1 @ 36.94 =	36.94 × 2 =		73.88
1 @ 22.36 =	22.36 × 2 =		44.72
2 @ 15.34 =	30.68 × 2 =		61.36
1 @ 18.47 =	18.47 × 2 =		36.94
1 @ 15.34 =	15.34 × 2 =		30.68
1 @ 4.22 =	4.22 × 2 =		~~8.44~~
			256.02

ROOF

$42 \times 29 = 1218$

FLOOR

ROOF × 2 − (3 × 11) = 609 × 2 − 33 = 1185 × 2 = 2370

SIMONS

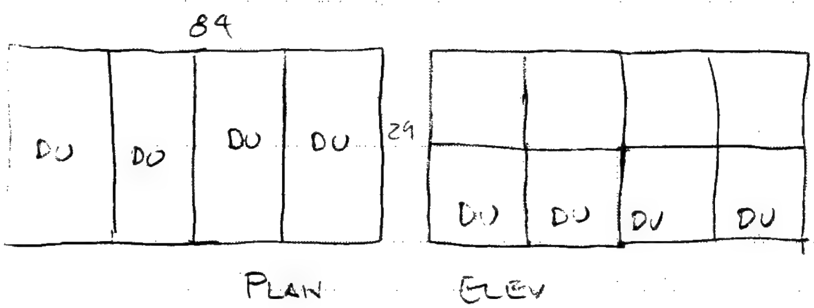
CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT Housing - Takeoffs of Typ. Areas SHEET NO. 5 OF 9 JOB NO. 7469 15

BY LLS DATE 7/24/92 CHKD. BY DATE

1 EM 1 (SP) 4 DU



TYPE - 2 STORY 3 BR QUAD - 4 DU
WALLS - 3616 - 512.04 = 3103.96
GLASS - 512.04
ROOF - 2436
BLDG. FLR. - 4740

WALLS

21 x 4 x 8 x 2 x 2 = 2688
29 x 8 x 2 x 2 = 928
3616

GLASS

1 @ 36.94 = 36.94 x 4 = 147.76
1 @ 22.36 = 22.36 x 4 = 89.44
2 @ 15.34 = 30.68 x 4 = 122.72
1 @ 18.47 = 18.47 x 4 = 73.88
1 @ 15.34 = 15.34 x 4 = 61.36
1 @ 4.22 = 4.22 x 4 = 16.88
512.04

ROOF

84 x 29 = 2436

FLOOR

ROOF x 2 - (3 x 11) = 21 x 29 x 2 - 33 = 1185 x 4 = 474

SIMONS

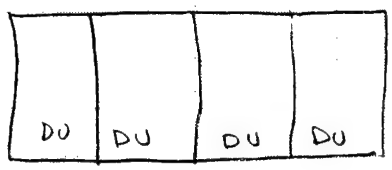
CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

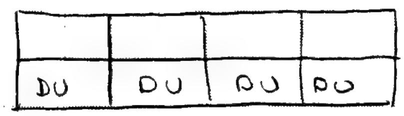
SUBJECT Housing – Takeoffs of Typ. Area SHEET NO. 6 OF 9 JOB NO. 7469 B

BY LLS DATE 7/24/92 CHKD. BY ________ DATE ________

1 EM 2 (SP) 4DU



PLAN



ELEV.

TYPE – 2 STORY 4 BR QUADPLEX – 4 DU
WALLS – 3616 – 512.04 = 3103.96
GLASS – 512.04
ROOF – 2436
BLDG. FLOOR – 4740

WALLS

21 × 4 × 8 × 2 × 2 = 2688
29 × 8 × 2 × 2 = 928
3616

GLASS

1 @ 36.94	=	36.94 × 4	=	147.76
1 @ 22.36	=	22.36 × 4	=	89.44
2 @ 15.34	=	30.68 × 4	=	122.72
1 @ 18.47	=	18.47 × 4	=	73.88
1 @ 15.34	=	15.34 × 4	=	61.36
1 @ 4.22	=	4.22 × 4	=	16.88
				512.04

ROOF

21 × 29 × 4 = 2436

FLOOR

ROOF × 2 – (3 × 11) = 609 × 2 – 33 = 1185 × 4 = 4740

SIMONS

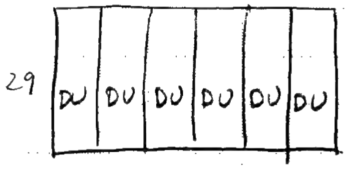
CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

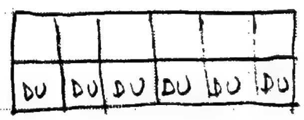
SUBJECT Housing - TAKEOFFS of Typ Areas SHEET NO. 7 OF 9 JOB NO. 7469 B

BY LLS DATE 7/24/92 CHKD. BY ______ DATE ______

1 EM 1 (SP) 6 DU



PLAN



ELEV.

TYPE - 2 STORY 3BR SIXPLEX - 6DU
WALLS - 4960 - 786.06 = 4173.94
GLASS - 786.06
ROOF - 3654
FLOOR - 7110

WALLS

$21 \times 6 \times 8 \times 2 \times 2 = 4032$
$29 \times 8 \times 2 \times 2 = 928$
4960

GLASS

1@ 36.94	=	36.94 × 6	=	239.64
1@ 22.36	=	22.36 × 6	=	134.16
2@ 15.34	=	30.68 × 6	=	184.08
1@ 18.47	=	18.47 × 6	=	110.82
1@ 15.34	=	15.34 × 6	=	92.04
1@ 4.22	=	4.22 × 6	=	25.32
				786.06

ROOF

$21 \times 29 \times 6 = 3654$

FLOOR

ROOF × 2 - (3×11) = 21×29×2 - 33 = 1185 × 6 = 7110

SIMONS

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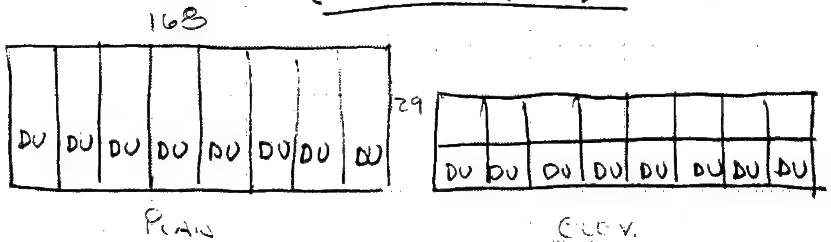
CALCULATION SHEET

SUBJECT Housing - Takeoffs of Typ. Areas SHEET NO. 8 OF 9 JOB NO. 7469 B

BY US DATE 7/24/92 CHKD. BY DATE 7/24/92

ICG01/IE
(1EM1(SP) 8DU)



TYPE - 2 STORY 3 BR EIGHTPLEX - 8 DU
WALLS - 6304 - 1024.08 = 5279.92
GLASS - 1024.08
ROOF - 4872
BLDG. FLR - 9480

WALLS

$21 \times 8 \times 8 \times 2 \times 2 = 5376$
$29 \times 8 \times 2 \times 2 = 928$
6304

GLASS

1@ 36.94 = 36.94 × 8 = 295.52
1@ 22.36 = 22.36 × 8 = 178.88
2@ 15.34 = 30.68 × 8 = 245.44
1@ 18.47 = 18.47 × 8 = 147.76
1@ 15.34 = 15.34 × 8 = 122.72
1@ 4.22 = 4.22 × 8 = 33.76
1024.08

ROOF

$168 \times 29 = 4872$

FLOOR

ROOF × 2 − (3×11) = 21×29×2 − 33 = 1185 × 8 = 9480

CALCULATION SHEET

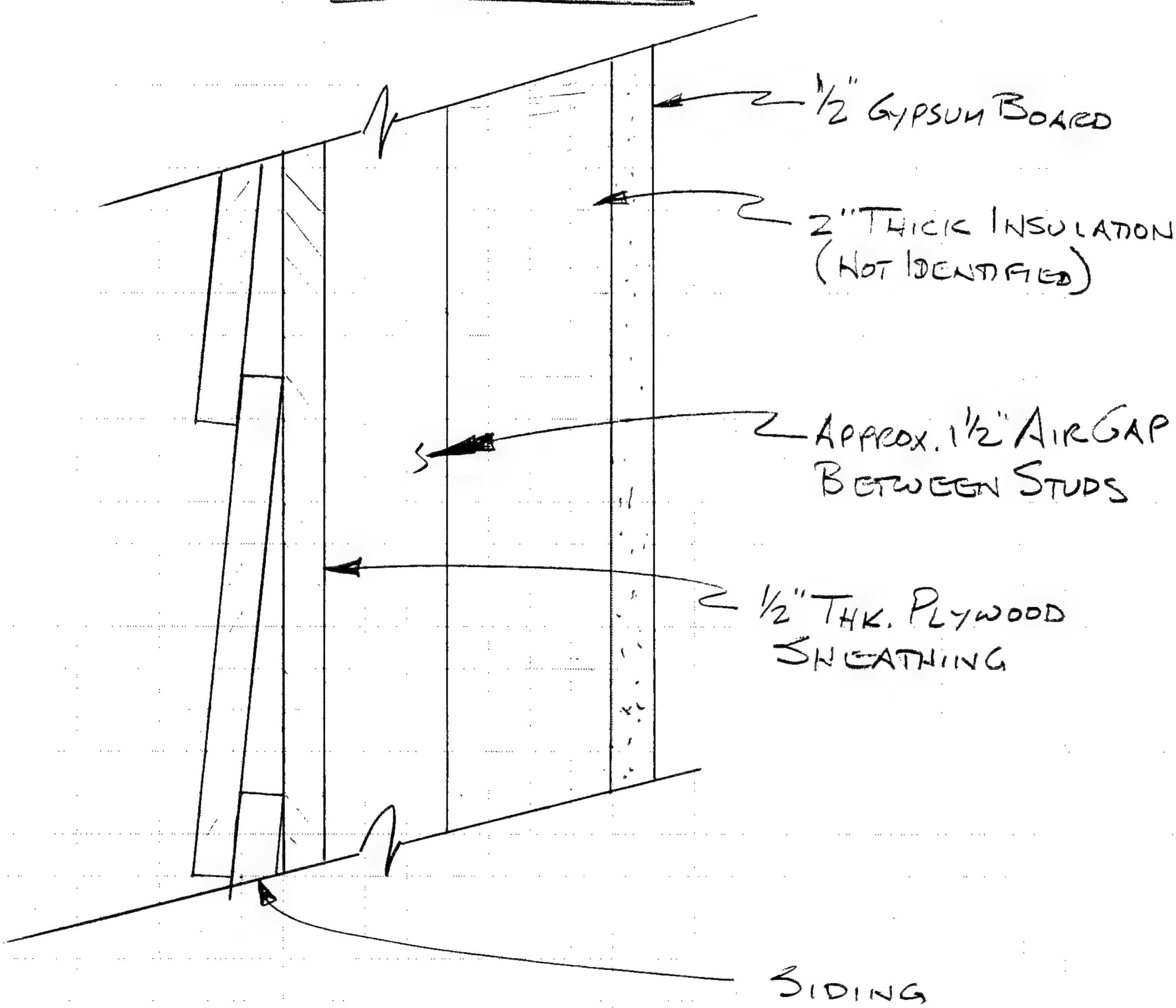
SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT Housing - Typical Wall Section SHEET NO. 9 OF 9 JOB NO. 74698

BY LLS DATE 7/24/92 CHKD. BY ______ DATE ______

TYPICAL EXTERIOR WALL SECTION

FAMILY HOUSING



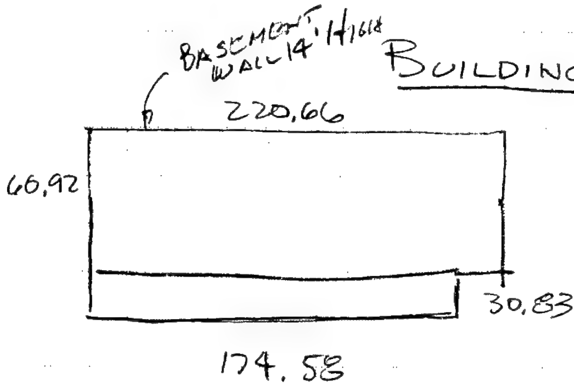
ROOF INSULATION = 4" BATT

CALCULATION SHEET

SIMONS
SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT Building - Takeoffs of Typical Areas SHEET NO. 1 OF 13 JOB NO. 7469 B
BY LLS DATE 7/28/92 CHKD. BY ______ DATE ______

Building 18400 (EM Club)



Type - 1 Story With Basement Under Main Bldg., Brick Walls, Asphalt Shingle Roof, Long Basement Wall 14'-0" High Of 1'-0" Thick Poured Concrete Exposed To Weather.

Walls - 7485.84 - 898.3 = 6587.54
Glass - 898.3 Plus 216.25 In Basement
Roof Area - 18824.9
Floor Area - 32267.5
Basement Wall - 3089.24 - 216.25 = 2873

Walls (From Prop Card, Assume 12' High)

220.66 x 12 x 2 = 5295.84
60.92 x 12 x 2 = 1450.08
30.83 x 12 x 2 = 739.92
= 7485.84

Glass

Assume Glass Is 12% Of Wall Surface Area
7485.84 x 12% = 898.3

Basement Wall (1' Thick Poured Conc)

220.66 x 14 = 3089.24

Glass

Assume 7% Of Wall Surface
3089.24 x .07 = 216.25

Roof

(220.66 x 60.92) + (174.58 x 30.83)
13442.61 + 5382.3 = 18824.9

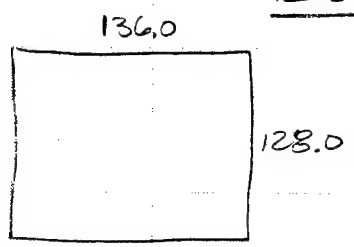
Floor (Includes Basement)

220.66 x 60.92 x 2 = 26885.21
174.58 x 30.83 = 5382.30
32267.51

SUBJECT Buildings - Takeoffs of Typ Areas SHEET NO. 2 OF 13 JOB NO. 24691B

BY LLS DATE 7/28/92 CHKD. BY ____ DATE ____

BUILDING 18402 (NCO OPEN MESS)



PLAN

TYPE – 1 STORY, BRICK VENEER INSULATED STEEL FRAME WALLS WITH GYP. BOARD, CEILING/ROOF IS BUILT-UP ON STEEL DECK INSULATED AND WITH DBL. GYP. BOARD

WALLS – 6336 – 760 = 5576
GLASS – 760
ROOF AREA – 17408
FLOOR AREA – 17408

WALLS (FROM PROP. CARD; 12' HIGH)

136 x 12 x 2 = 3264
128 x 12 x 2 = 3072
6336

GLASS

ASSUMED 12% OF TOTAL AVAIL. WALL AREA.
6336 x 12% = 760.32

ROOF

128 x 136 = 17408

FLOOR

SAME AS ROOF

SIMONS

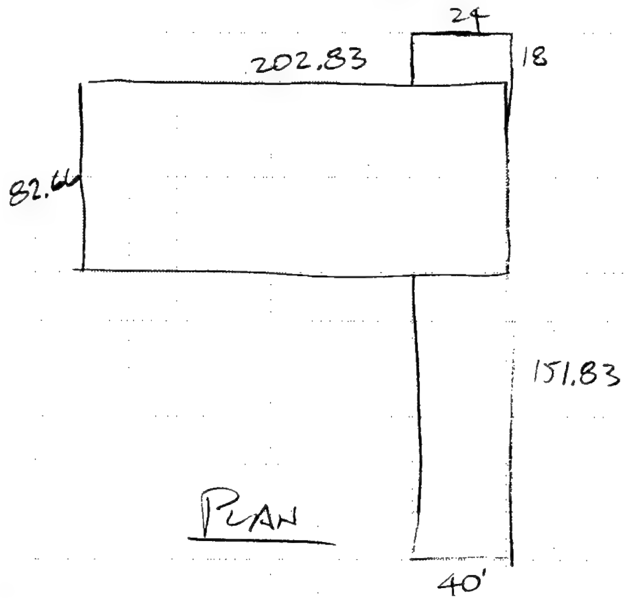
CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT Building - Takeoffs of Typ Areas SHEET NO. 3 OF 13 JOB NO. 7469 13

BY LLS DATE 7/28/92 CHKD. BY ______ DATE ______

BUILDING 21608



TYPE - 1 STORY, CONCRETE MASONRY WALLS
BUILT UP ROOF, 10' WALLS

WALLS - 9106.4 - 1092.77 = 8013.6

GLASS - 1092.77

ROOF - 23271.13

FLOOR - 23271.13

WALLS (10' HIGH, FROM PROP. CARD)

82.66 x 10 x 2 =	1653.2
202.83 x 10 x 2 =	4056.6
151.83 x 10 x 2 =	3036.6
18 x 10 x 2 =	360.0
	9106.4

GLASS

ASSUME 12% OF GROSS WALL CALC.

9106.4 x 12% = 1092.77

ROOF

202.83 x 82.66 =	16765.93
18 x 24 =	432
151.83 x 40 =	6073.2
	23271.13

FLOOR

SAME AS ROOF

SIMONS

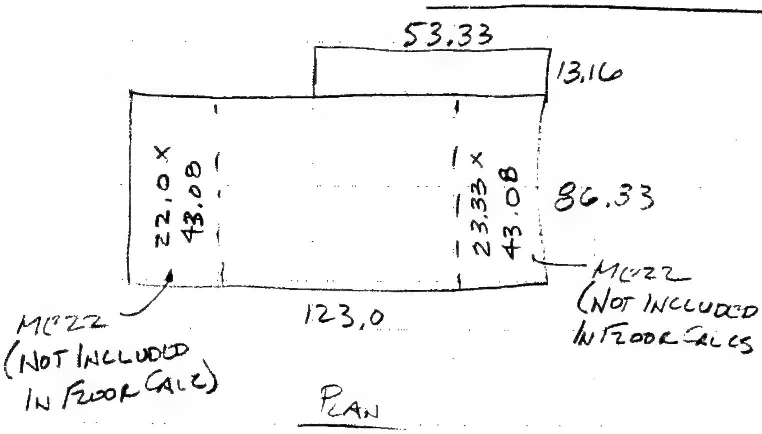
CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT Building - Takeoff of Typ Areas SHEET NO. 4 OF 13 JOB NO. 7469B

BY LLS DATE 7/28/92 CHKD. BY DATE

BUILDING 21709



TYPE - 1 STORY HIGH ROOF, CONC. BLOCK W/BRICK VENEER, BUILT-UP ROOF. MAIN BUILD. WALLS = 20', OFFSET = 10'.

WALLS - 11005.2 - 1320.62 = 9684.6
GLASS - 1320.62
ROOF - 11320.41
FLOOR - 11320.41

WALLS (FROM PROP. CARD, WALLS VARY)

MAIN BUILD. (20' HIGH)

123 x 20 = 2460
(123 x 20) - (53.33 x 10) = 1926.7
86.33 x 20 x 2 = 3453.2
13.16 x 10 x 2 = 2632
53.33 x 10 = 530.3
11005.2

GLASS

ASSUME 12% OF GROSS WALL CALC.

11005.2 x .12 = 1320.62

ROOF

86.33 x 123 = 10618.59
53.33 x 13.16 = 701.82
11320.41

FLOOR

SAME AS ROOF

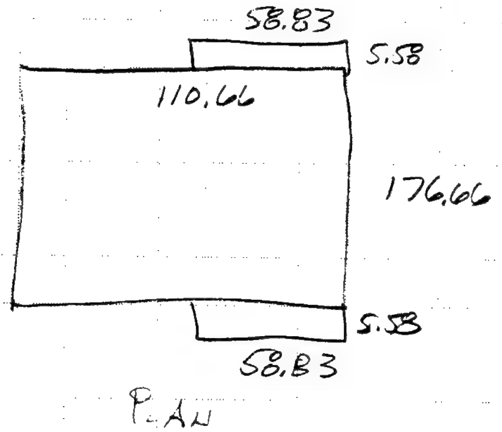
SIMONS

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

CALCULATION SHEET

SUBJECT: Buildings – Takeoffs of Typ. Areas SHEET NO. 5 OF 13 JOB NO. 7469B
BY: LLS DATE: 7/28/92 CHKD. BY: ______ DATE: ______

BUILDING 24414



TYPE – 1 STORY

WALLS – 7163.52 – 859.62 = 6303.
GLASS – 859.62
ROOF AREA – 20205.74
FLOOR AREA – 20205.74

WALLS (PROP. CARD; 12' HIGH)

176.66 × 12 × 2 = 4239.84
110.66 × 12 × 2 = 2655.84
5.58 × 12 × 4 = 267.84
7163.52

GLASS

ASSUME 12% OF GROSS WALL CALC.
7163.52 × .12 = 859.62

ROOF

176.66 × 110.66 = 19549.2
58.83 × 5.58 × 2 = 656.54
20205.74

FLOOR

SAME AS ROOF

SIMONS

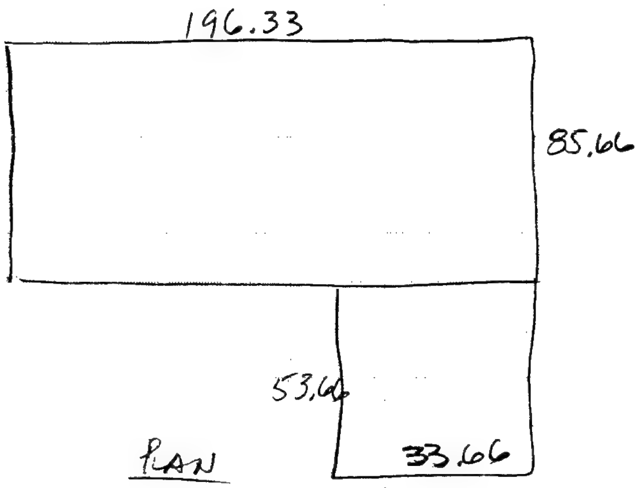
CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT Buildings - Take offs of Typ. Areas SHEET NO. 6 OF 13 JOB NO. 74693

BY LLS DATE 7/28/92 CHKD. BY ______ DATE ______

BUILDING 29300



TYPE - 1 STORY, CONCRETE BLOCK WALL, METAL DECK ROOF

WALLS - 8055.6 - 966.67 = 7089

GLASS - 966.67

ROOF - 18623.82

FLOOR - 18623.82

WALLS (FROM PROP. CARD; 12' WALLS)

196.33 X 12 X 2 = 4711.92

85.66 X 12 X 2 = 2055.84

53.66 X 12 X 2 = 1287.84

8055.6

GLASS

ASSUME 12% OF GROSS WALL CAL

8055.6 X .12 = 966.67

ROOF

196.33 X 85.66 = 16817.63

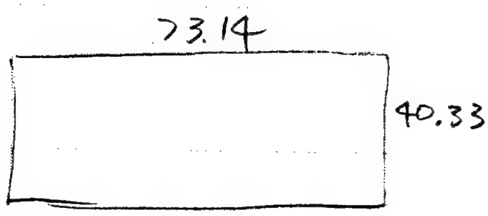
33.66 X 53.66 = 1806.19

18623.82

FLOOR

SAME AS ROOF

BUILDING 35402



PLAN

TYPE – 1 STORY, WOOD FRAME BRICK VENEER WALLS, WOOD COMPOSITE SHINGLED ROOF.

WALLS – 2269.4 – 680.82 = 1588.58
GLASS – 680.82
ROOF – 2949.74
FLOOR – 2949.74

WALLS (PROP. CARD, 10' HIGH)

73.14 x 10 x 2 = 1462.8
40.33 x 10 x 2 = 806.6
2269.4

GLASS

ASSUME 30% OF GROSS WALL CALC
2269.4 x .3 = 680.82

ROOF

73.14 x 40.33 = 2949.74

FLOOR

SAME AS ROOF

SIMONS

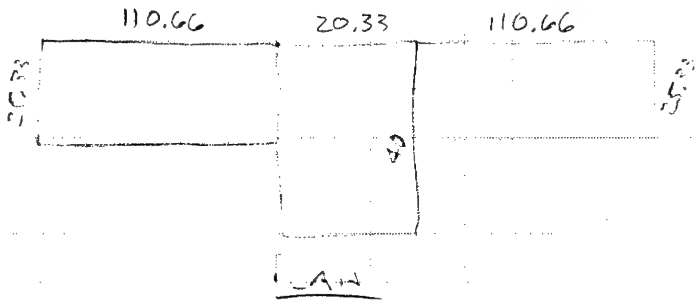
CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT Buildings - Takeoffs of Typ. Areas SHEET NO. 8 OF 13 JOB NO. 7469B

BY LLS DATE 7/28/92 CHKD. BY DATE

BUILDING 39005



TYPE - 1 Story; Concrete & Metal Walls, Metal & Built-Up Roof.

WALLS - 6759.6 - 475.83 = 6283.77

GLASS - 475.83

ROOF AREA - 6419.24

FLOOR AREA - 6419.24

WALLS (From Prop. Record)

110.66 x 12 x 4 = 5311.68

25.33 x 12 x 2 = 607.92

20.33 x 12 x 2 = 487.92

(40 - 25.33) x 12 x 2 = 352.08

6759.60

GLASS (From Bill's Survey)

66 x 46 ÷ 144 x 22 = 463.83

24 x 36 ÷ 144 x 2 = 12.00

475.83

ROOF

2(110.66 x 25.33) + (20.33 x 40) =

5606.04 + 813.2 = 6419.24

FLOOR

Same As Roof

SIMONS

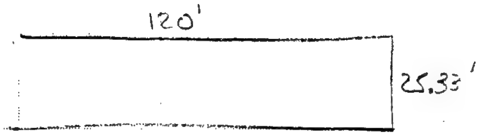
CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT Buildings - Takeoffs of Typ Areas SHEET NO. 9 OF 13 JOB NO. 7469B

BY LLS DATE 7/28/92 CHKD. BY DATE

BUILDING 39007



PLAN

TYPE - 1 STORY, CONCRETE BLOCK WALLS, ASPHALT SHINGLE ROOF.

WALLS 2906.6 - 391.5 = 2515.1

GLASS - 391.5

ROOF AREA - 3039.6

FLOOR AREA - 3039.6

WALLS (FROM PROP. RECORDS)

120 x 10 x 2 = 2400

25.33 x 10 x 2 = 506.6

2906.6

GLASS (FROM SMITH'S SURVEY)

66 x 46 ÷ 144 x 18 = 379.5

24 x 36 ÷ 144 x 2 = 12.0

391.5

ROOF

120 x 25.33 = 3039.6

FLOOR

SAME AS ROOF

SIMONS

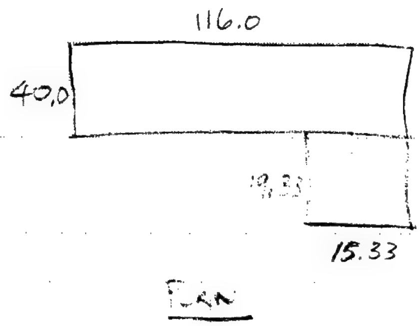
CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT Buildings - Take off of Typ Areas SHEET NO. 10 OF 13 JOB NO. 7469B

BY LLS DATE 7/28/92 CHKD. BY ______ DATE ______

BUILDIN 39105 (MESS HALL)



TYPE - 1 STORY, CONCRETE BLOCK WALLS, ASPHALT SHINGLE ROOF

WALLS - 4023.96 - 403.5 = 3620.46

GLASS - 403.5

ROOF AREA - 4936.33

FLOOR AREA - 4936.33

WALLS (FROM PROP. REC.)(ASSUMED 12' HIGH)

116 × 12 =	1392
40 × 12 × 2 =	960
(116 - 15.33) × 12 =	1208.04
19.33 × 12 × 2 =	463.92
	4023.96

GLASS (FROM SMITH'S SURVEY)

$$\frac{(66 \times 46)}{144} \times 18 = 379.5$$

$$\frac{24 \times 36}{144} \times 4 = 24.0$$

403.5

ROOF

(116 × 40) + (19.33 × 15.33) =

4640 + 296.33 = 4936.33

FLOOR

SAME AS ROOF

SIMONS

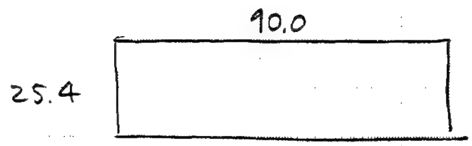
CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT Buildings - Takeoffs of Typ. Areas SHEET NO. 11 OF 13 JOB NO. 7469B

BY LLS DATE 7/28/92 CHKD. BY ____ DATE ____

BUILDING 39111



PLAN

TYPE - 1 STORY, MASONRY BLOCK WALLS, ASPHALT SHINGLE ROOF

WALLS - 2769.6 - 361.33 = 2408.27

GLASS - 361.33

ROOF AREA - 2286

FLOOR AREA - 2286

WALLS (FROM PROP. REC.)(ASS. 12' WALLS)

$(90 \times 12 \times 2) + (25.4 \times 12 \times 2) =$

$2160 + 609.6 = 2769.6$

GLASS (FROM SMITH'S SURVEY)

$\frac{66 \times 46}{144} \times 16 = 337.33$

$\frac{24 \times 36}{144} \times 4 = 24.00$

361.33

ROOF

$90 \times 25.4 = 2286$

FLOOR

SAME AS ROOF

SIMONS

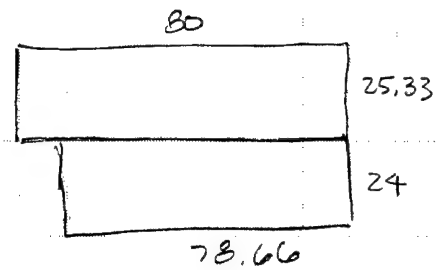
CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT Buildings - Takeoffs of Typ Areas SHEET NO. 12 OF 13 JOB NO. 7469B

BY LLS DATE 7/28/92 CHKD. BY ______ DATE ______

BUILDING 39211



PLAIN

TYPE - 1 STORY, CONC. BLOCK WALLS, ASPHALT SHINGLE ROOF

WALLS - 3103.92 - 355.33 = 2748.59

GLASS - 355.33

ROOF AREA - 3914.24

FLOOR AREA - 3914.24

WALLS (FROM PROP. CARD)(12' WALLS)

$80 \times 12 \times 2 =$ 1920

$24 \times 12 \times 2 =$ 576

$25.33 \times 12 \times 2 =$ 607.92

3103.92

GLASS (FROM SMITH'S SURVEY)

$\frac{66 \times 46}{144} \times 16 = 337.33$

$\frac{24 \times 36}{144} \times 3 = 18$

355.33

ROOF

$(80 \times 25.33) + (78.66 \times 24)$

$2026.4 + 1887.84 = 3914.24$

FLOOR

SAME AS ROOF

SIMONS

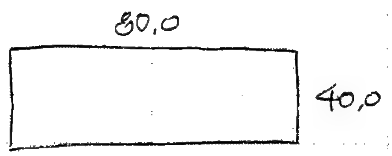
CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT Buildings - Takeoffs of Typ. Areas SHEET NO. 13 OF 13 JOB NO. 7469 B

BY LLS DATE 7/28/92 CHKD. BY ____ DATE ____

BUILDING 40201



PLAN

TYPE - 1 STORY, MASONRY BLOCK WALLS, ASPHALT ROOF SHINGLES.

WALLS - 2880 - 403.5 = 2476.5

GLASS - 403.5

ROOF AREA - 3200

FLOOR AREA - 3200

WALLS (FROM PROP. REC.; 12' WALLS)

80x12x2 = 1920

40x12x2 = 960

2880

GLASS (SMITH'S SURVEY)

$\frac{66 \times 46}{144} \times 18 = 379.5$

$\frac{24 \times 36}{144} \times 4 = 24$

403.5

ROOF

80x40 = 3200

FLOOR

SAME AS ROOF

SIMONS

CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT Ft. Gordon - Firm Gas Cost SHEET NO. 1 OF 4 JOB NO. 7469 B

BY JMK DATE CHKD. BY DATE 7-31-92

	FIRM THERMS	INTERR. THERMS	Δ PGA Cents/therm	FRANC. REC. FACT	
7-90	235,638				
8-90	230,103				
9-90	250,132				
10-90	334,661 (5)	5,859	13.57	.0136	
11-90	388,603 (20)	41,914	13.67	.0136	
12-90	413,543 (28)	189,552	13.12	.0136	
1-91	418,500 (31)*	332,911	14.77	.0141	
2-91	378,000 (28)*	224,050	14.82	.0141	
3-91	397,150 (23)	105,756	15.67	.0139	
4-91	233,998		16.15	.0139	
5-91	237,949		15.31	.0130	
6-91	215,726		15.01	.0130	
	3,734,003 (135)	900,042	14.68 avg	.0136 avg	
7-91	185,728		15.44	.0130	
8-91	208,213		15.12	.0129	
9-91	270,123		15.22	.0129	
10-91	315,585		14.92	.0129	
11-91	393,904 (25)	165,835	14.60	.0129	
12-91	417,474 (29)	283,015	14.55	.0129	
1-92	418,500 (31)*	433,157	14.83	.0122	19 hrs. curtailment
2-92	391,500 (29)*	268,252	15.24	.0122	
3-92	413,622 (28)	188,175	14.88	.0125	
4-92	313,368 (10)	68,618	13.99	.0124	
5-92	283,943 (3)	3,652	14.30	.0124	
6-92	275,225	812	14.59	.0124	
	3,887,185 (155)	1,411,516	14.81 avg	.0126 avg	

CALCULATION SHEET

SIMONS

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT Ft. Gordon - Firm Gas Cost SHEET NO. 2 OF 4 JOB NO. 7469 B

BY JMK DATE CHKD. BY DATE 7-31-92

July 1990 thru June 1991

1. Firm Use Charge	= 13,500 therms/day x $15.60	=	210,600
2. Δ PGA	= 3,734,003 therms x $.1468	=	548,152
3. Franc. Rec.	= (210,600 + 548,152) x .0136	=	10,319
	TOTAL	=	$769,071

July 1991 thru June 1992

1. Firm Use Chg	=	=	210,600
2. Δ PGA	= 3,887,185 therms x $.1481	=	575,692
3. Franc. Rec	= (210,600 + 575,692) x .0126	=	9,907
			$796,199

SIMONS

CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT Ft. Gordon - Firm Gas Cost SHEET NO. 3 OF 4 JOB NO. 7469 B

BY JMK DATE CHKD. BY DATE 7-31-92

	FIRM THERMS	INTERR. THERMS	
7-88	342,118		
8-88	341,647		
9-88	339,986		
10-88	414,222	105,090	
11-88	413,100 *	229,316	
12-88	427,288 *	427,012	
1-89	427,289 *	371,398	
2-89	385,938 *	306,739	26 hours curtailment
3-89	427,288 *	284,961	
4-89	378,924	81,486	
5-89	334,224		
6-89	247,416		
	4,479,439	1,806,002	⇒ $882,600 firm cost (extrapolated)

7-89	224,359		
8-89	277,763		
9-89	414,720	295,895	
10-89	383,902	47,324	
11-89	415,709	142,372	
12-89	422,354	339,557	151 hours curtailment
1-90	418,500 (31)*	305,488	
2-90	378,000 (28)*	212,755	
3-90	417,710 (30)	163,292	
4-90	392,643 (19)	61,107	
5-90	354,934		
6-90	299,151		
	4,399,745	1,567,790	⇒ $870,700 firm cost (extrapolated)

SIMONS

CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT Ft. Gordon - Firm Gas Cost SHEET NO. 4 OF 4 JOB NO. 7469B

BY JMK DATE CHKD. BY DATE 7-31-92

"PREMIUM" COST FOR FIRM GAS

1988-1989	$ 882,600
1989-1990	$ 870,700
1990-1991	$ 769,071
1991-1992	$ 796,199
	3,318,570 over 4 years

=> $ 829,643 avg per year

Gas Use (therms)	Firm	Interr.	Total
1988-1989	4,479,439	1,806,002	
1989-1990	4,399,745	1,567,790	
1990-1991	3,734,003	900,042	
1991-1992	3,887,185	1,411,516	
Total	16,500,372	5,685,350	22,185,722
Avg/year	4,125,093	1,421,338	5,546,431
Avg/day	11,301		

Per therm premium for firm gas (average)

$$\frac{\$\,829,643}{4,125,093} = 20.11 \text{ cents/therm}$$

SIMONS

SUMMARY OF PROPANE SYSTEM ALTERNATIVE CAPACITIES
FORT GORDON, GEORGIA

	VAPORIZER SIZE			LPG STORAGE		
DESCRIPTION	MM BTUH	THERM/DAY	GPH	TANK SIZES (GALLONS)	# TANKS	TOTAL STORAGE (GALLONS)
100% Stanby	230	55,200	2,512	30,000	6	153,000
Peach Shave, Firm = 10,000	71	17,000	776	30,000	2	51,000
Peach Shave, Firm = 8,500	77	18,500	841	30,000	3	76,500

SIMONS

CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT 100 % STANDBY SIZE, Firm = O SHEET NO. 1 OF 2 JOB NO. 746913

BY GWS DATE 7-31-92 CHKD. BY ______ DATE ______

STORAGE Requirement

Purpose: DETURMINE TANKAGE Reqmt for 10 DAY STORAGE of LPG for Full backup of NG

Basis:
1.) DAILY FUEL USAGE = 13,500 THerms/DAY
2.) LPG: 91,547 BTU/GAL [HEAT CONTENT]
3.) 1 THeRm = 100,000 BTU
4.) TANK SIZE IS 30,000 GALLONS
5.) MAX. Tank Capacity = 85% x 30,000 = 25,500 gal

CALCULATION:

1) No. OF TANKS Req'd for 1 day STORAGE

$$= 13{,}500 \frac{\text{Therm}}{\text{DAY}} \times 100{,}000 \frac{\text{BTU}}{\text{Therm}} \times \frac{\text{GAL}}{91{,}547 \text{ BTU}} \times \frac{\text{TANK}}{25500 \text{ GAL}}$$

$$= .5783 \text{ TANKS/DAY}$$

2) No. OF TANKS for 10 DAY STORAGE

$$= \left(.5783 \frac{\text{Tank}}{\text{DAY}}\right)(10 \text{ DAYS}) -$$

$$= 5.78 \quad \underline{(6 \text{ TANKS})}$$

3) 6 TANKS CAPACITY

$$\frac{6}{5.78} \times 13{,}500 \frac{\text{therm}}{\text{day}} = 14{,}014 \frac{\text{therm}}{\text{day}}$$

SIMONS

CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT 100% STANDBY, FIRM = 0 SHEET NO. 2 OF 2 JOB NO. 74691B

BY GWS DATE 7-31-92 CHKD. BY DATE

VAPORIZER SIZE

Purpose: Determine Propane Vaporizer SIZE for 100% STANDBY of NATURAL GaS

Basis:
1) Size for TOTAL connected load
2) Propane Air Mixture = 54.9% Propane / 45.1% Air
   SG = 1.287
   BTU/SCF = 1400 BTU/SCF
3) Density of Propane/Air Mix at given Press. + Temp: $\rho = \frac{2.7 \times P_S \times SG}{(T+460)}$ (CRANE 410, A-10)
4) 1 THERM = 100,000 BTU
5) 1 GAL Propane = 91,547 BTU

Calculations:

1) TOTAL Connected LOAD (Per LOAD Estimates)

Housing	128 MM BTUH
Buildings	102 MM BTUH
	230 MM BTUH

2) VAPORIZER MIXER SIZE

$$\frac{230 \text{ MM BTUH}}{100{,}000 \text{ BTU/Therm}} \times 24 \frac{\text{HR}}{\text{DAY}} = 55{,}200 \text{ Therm/DAY}$$

3) Volume of Mixture Required

$$V_M = \frac{230 \text{ MM BTUH}}{1400 \text{ BTU/SCF}} \times \frac{\text{HR}}{60 \text{ MIN}} = 2738 \text{ SCFM (Mixture)}$$

4) Volume OF PROPANE Required

$$\frac{230 \text{ MM BTUH}}{91{,}547 \text{ BTU/GAL}} = 2512 \text{ GAL/HR}$$

CALCULATION SHEET

SIMONS

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT Peak Shave Size - Firm = 10,000 T/D SHEET NO. 1 OF ___ JOB NO. 7469 B

BY GWS DATE 8-5-92 CHKD. BY ___ DATE ___

Purpose: Determine Propane Vaporizer size + Storage for Peak Shave System with Firm Gas committment of 10,000 THERM/DAY.

Basis:
1) Firm Gas Commitment = 10,000 Therm/Day
2) Max Monthly Usage = 27,000 Therm/Day
3) Storage for 10 Days @ 13,500 Therm/Day
4) Tank Capacity 25,500 gal/Tank
5) Propane Equivalents
   1 Gallon = 91,547 BTU
   = .916 Therm

Calculations:

1) Vaporizer & Mixer Size

$$\frac{27\,000 \text{ THERM}}{\text{DAY}} - \frac{10{,}000 \text{ Therm}}{\text{DAY}} = 17{,}000 \text{ THERM/DAY}$$

2) Storage Requirement

THERMS STG = (13,500 − 10,000) 10

= 35,000 THERMS

3) No of Tanks

$$\text{TANKS} = 35{,}000 \text{ Therm} \times \frac{\text{GAL}}{.916 \text{ Therm}} \times \frac{\text{TANK}}{25{,}500 \text{ GAL}}$$

= 1.50 (2 TANKS)

SIMONS

CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT Peak Shave Size - Firm = 8,500 T/D SHEET NO. ____ OF ____ JOB NO. 7469 B

BY GWS DATE 8-5-92 CHKD. BY ______ DATE ______

Purpose: Determine Propane Vaporizer Size + Storage for Peak Shave System with Firm Gas committment of 8,000 THERM/DAY.

Basis:
1) Firm Gas Commitment = 8,500 THERM/DAY
2) MAX MONTHLY USAGE = 27,000 THERM/DAY
3) STORAGE for 10 DAYS @ 13,500 THERM/DAY
4) TANK Capacity 25,500 gal/TANK
5) Propane Equivalents
   1 GALLON = 91,547 BTU
   = .916 THERM

Calculations:

1) VAPORIZER & MIXER SIZE

$$\frac{27\,000 \text{ THERM}}{\text{DAY}} - \frac{8{,}500 \text{ THERM}}{\text{DAY}} = 18{,}500 \text{ THERM/DAY}$$

2) STORAGE Requirement

$$\text{THERMS STG} = (13{,}500 - 8{,}500)\,10$$

$$= 50{,}000 \text{ THERMS}$$

3) No OF TANKS

$$\text{TANKS} = 50{,}000 \text{ THERM} \times \frac{\text{GAL}}{.916 \text{ THERM}} \times \frac{\text{TANK}}{25{,}500 \text{ GAL}}$$

$$= 2.14 \quad \underline{(3 \text{ TANKS})}$$

SIMONS

CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT Reduction of Firm Gas - Basis SHEET NO. 1 OF 1 JOB NO. 746913
BY GWS DATE 8-5-92 CHKD. BY ______ DATE ______

Basis for Firm Gas Reductions

① 10,000 Therms/Day

The facility reduced total NG consumption to this figure during the December 1989 Curtailment.

② 8500 Therms/Day

This is the average of the June, July + August gas consumptions over the past 4 year period

③ 13,000 Therms/Day

This is the average of the daily gas consumptions during the Dec. 1989 Curtailment. (Full day usages only)

SIMONS

CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT LCCID COST CALCULATIONS SHEET NO. 1 OF 8 JOB NO. 7467 B

BY GWS DATE 8-6-92 CHKD. BY ______ DATE ______

ASSUMPTIONS

1. INVESTMENT

   B. SIOH IS 6% OF CONST COST (per LCCID)
   C. DESIGN IS 6% OF CONST COST (per LCCID)

2. ENERGY SAVINGS

   C. NAT G COST BASED ON 50¢/GALLON + 91,547 BTU/GALLON

   Energy SAVINGS (BTU/HR) CALCULATED based ON KNOWN ANNUAL $ SAVINGS

3. Annual Reoccuring Cost

   Maint + Repair = 3% of MECHANICAL COSTS ONLY (EST)

   PENALTY = $3.00/THERM ON diff. between Current Firm Gas comm + New Firm Gas commit. BASED ON 48 hr/yr Average curtailment over the past 4 years. (PERCE DATA)

CALCULATION SHEET

SIMONS

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT LCGID COST CALCULATIONS SHEET NO. 2 OF 8 JOB NO.

BY GWS DATE 8/10/92 CHKD. BY DATE

AVE ANNUAL HOURS OF CURTAILMENT

YEAR	HOURS	
1991	19	
1990	0	
1989	151	→ AVE 13000 THERM/DAY ←
1988	26	

196 HRS OVER 4 YEARS (49 HRS/YR)

SIMONS

CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT LCCID Cost Calculations SHEET NO. 3 OF 8 JOB NO. 746913

BY GWS DATE 9/2/92 CHKD. BY ______ DATE ______

Summary

	CAPITAL INVEST	ENERGY SAVINGS MMBTU	ENERGY SAVINGS DOLLARS	PENALTY COST	M+R COST	
FIRM = 10,000, 2 DAY	0	39,411	215,185	21,000	0	CHG Firm
Firm = 8500, 2 DAY	0	56,302	307,407	30,000	0	CHG Firm
Peak, Firm = 10,000	1,945,716	39,411	215,185	0	14,100	
PEAK, Firm = 8,500	2,029,882	56,302	307,407	0	15900	
100% STANDBY	2,413,556	152,015	830,000	0	25,050	
100% STANDBY w/o Pipe	1,300,216	152,015	830,000	0	25,050	
Firm = 0	0	152,015	830,000	81,000		
Firm = 10,000, 5 DAY	0	39411	215,185	52,500		CHG Firm
Firm = 10,000, 10 DAY	0	39411	215,185	105,000		CHG Firm
Firm = 8,500, 5 DAY	0	56,302	307,407	75,000		CHG Firm
Firm = 8500, 10 DAY	0	56,302	307,407	150,000		CHG Firm

SIOH = 6%
DESIGN = 6%
LIFE = 20 YR

SIMONS

CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT LCCID Cost Calculations SHEET NO. 4 OF 8 JOB NO. 74698

BY GWS DATE 9/2/92 CHKD. BY DATE

CAPITAL COSTS (UNESCALATED)

1) PROPANE STANDBY

• Propane System		1,189,703
VAPorizer/mixer/AC	450,000	
TANKS - 6	375,000	
OTHER	288,000	
LPG Fill (153,000 GAL)	76,500 @ $.50/GAL	
• NAT Gas Meter		19,800
• NAT GAS Pipeline		1,035,665
TOTAL		2,245,168
Contingency @ 7½%		168,388
		$ 2,413,556

2) PEAK Shave, Firm = 10,000 Therm/DAY

• Propane System		$ 754,503
VAPorizer/mixer/AC	325,000	
Tanks - 2	135,000	
OTHER	269,000	
LPG Fill	25,500	
• NAT Gas Meter		19,800
• NAT Gas Pipeline		1,035,665
TOTAL		1,809,968
Conting @ 7½%		135,748
		$ 1,945,716

CALCULATION SHEET

SIMONS

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT LCCID Cost Calculations SHEET NO. 5 OF 8 JOB NO. 746913

BY GWS DATE 9/2/92 CHKD. BY ______ DATE ______

CAPITAL COSTS (UNESCALATED)

3) Peak Shave, Firm=8500 THERM/DAY

• Propane System		$ 832,053
VAPOR/MIX/AC	325,000	
TANKS - 3	195,000	
OTHER	273,803	
LPG FILL	38,250	
• NAT Gas Meter		19,800
• NAT GAS Pipeline		1,035,665
TOTAL		1,887,518
CONTING @ 7½ %		141,564
		2,029,882

SIMONS

CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT LCCIID COST CALCULATIONS SHEET NO. 6 OF 8 JOB NO. 4469 B

BY GWS DATE 8/10/92 CHKD. BY DATE

ENERGY SAVINGS

1) BASIS

$$\frac{\text{Firm Reduction (Therm/Day)}}{\text{Current Firm (Therm/Day)}} \times [\text{Cost of Current Firm}] = \text{Energy Savings}$$

Current Firm = 13,500/DAY

Cost of Current Firm = $830,000/YR

2) ENERGY SAVINGS AT FIRM = 10,000 Therm/DAY

$$\frac{13500 - 10,000}{13500} \times \$830,000 = \underline{\$215,185/YR}$$

$$\text{SAVINGS} = \frac{215,185}{5.46} = 39411 \text{ MM BTU/YR}$$

3) ENERGY SAVINGS AT FIRM = 8500 THERM/DAY

$$\frac{13500 - 8500}{13500} \times 830,000 = \underline{\$307,407/YR}$$

$$\text{SAVINGS} = \frac{\$307,407}{\$5.46/\text{MMBTU}} = 56,302 \text{ MMBTU/YR}$$

4) ENERGY SAVINGS AT FIRM = 0

$$\frac{13500 - 0}{13500} \times 830,000 = \$830,000/\text{yr}$$

$$\text{SAVINGS} = \frac{\$830,000}{\$5.46/\text{mmBTU}} = 152,015 \text{ MMBTU/yr}$$

SIMONS

CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT LCCID COST CALCULATIONS SHEET NO. 7 OF 8 JOB NO. 7469B

BY GWS DATE 8/10/92 CHKD. BY ______ DATE ______

PENALTY (DUE TO REDUCED FIRM)

1) BASIS

$$\left[\begin{array}{c}\text{EXCESS GAS USAGE}\\ \text{THERMS/DAY}\end{array}\right] \times \left[\begin{array}{c}\text{AVE DURATION}\\ \text{OF CURTAILMT}\end{array}\right] \times \left[\begin{array}{c}\text{PENALTY}\\ \text{COST}\end{array}\right] = \text{ANNUAL PENALTY}$$

EXCESS GAS USAGE = CURRENT FIRM - NEW FIRM
= 13500 - NEW FIRM

AVE DURATION OF CURTAILMENT = 2 DAYS

PENALTY COST = $3.00/THERM

2) PENALTY AT FIRM = 10,000 THERMS/DAY

$(13{,}500-10{,}000) \times (2\ \text{DAY}) \times (\$3.00/\text{THERM}) = \underline{\$21{,}000/\text{YR}}$

3) PENALTY AT FIRM = 8500 THERM/DAY

$(13{,}500-8{,}500) \times (2\ \text{DAY}) \times (\$3.00/\text{THERM}) = \underline{\$30{,}000/\text{YR}}$

4) PENALTYS FOR 5 + 10 DAY CURTAILMENT

FIRM = 10,000	5 DAY	52,500/YR
	10 DAY	105,000/YR
FIRM = 8,500	5 DAY	75,000/YR
	10 DAY	150,000/YR

SIMONS

CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT LCCID Cost Calculations SHEET NO. 2 OF 3 JOB NO. 7469 B

BY GWS DATE 8/10/92 CHKD. BY ______ DATE ______

MAINT + REPAIR COSTS

1) BASIS

ESTIMATE 3% OF VAPORIZER/MIXER/AIR COMPRESSOR, TANKS + TRUCK UNLOADING ONLY

2) Propane Standby

VAPORIZER/MIXER/AC	450,000
TANKS - 6	375,000
Truck unloading	10,000
	835,000
	X 3%
	$25,050/YR ←

3) Peak Shave, Firm = 10,000

VAP/MIX/AC	325,000
Tanks - 2	135,000
Truck unload	10,000
	470,000
	X 3%
	$14,100/YR ←

4) Peak Shave, Firm = 8500

VAP/MIX/AC	325,000
TANKS - 3	195,000
Truck unload	10,000
	530,000
	X 3%
	$15,900/yr ←

LIFE CYCLE COST ANALYSIS SUMMARY   STUDY: LPG1
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)   LCCID 1.065
INSTALLATION & LOCATION: FORT GORDON   REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 7469B   LPG STUDY
FISCAL YEAR 1995   DISCRETE PORTION NAME: FIRM=10000,5 DAY
ANALYSIS DATE: 09-02-92 ECONOMIC LIFE 20 YEARS PREPARED BY: G W SMITH

1. INVESTMENT

A. CONSTRUCTION COST	$	0.
B. SIOH	$	0.
C. DESIGN COST	$	0.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	0.

****** No investment costs; Items 3D1B and 6 should be checked. ******

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ .00	0.	$ 0.	13.68	0.
B. DIST	$ .00	0.	$ 0.	14.64	0.
C. RESID	$ .00	0.	$ 0.	16.00	0.
D. NAT G	$ 5.46	39411.	$ 215184.	17.25	3711925.
E. COAL	$ .00	0.	$ 0.	15.38	0.
F. TOTAL		39411.	$ 215184.		$ 3711925.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -52500.
(1) DISCOUNT FACTOR (TABLE A) 12.90
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -677250.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ -677250.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 1224935.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)_______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 162684.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 3034675.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= ******
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 .00

LIFE CYCLE COST ANALYSIS SUMMARY   STUDY: LPG1
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)   LCCID 1.065
INSTALLATION & LOCATION: FORT GORDON   REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 7469B   LPG STUDY
FISCAL YEAR 1995   DISCRETE PORTION NAME: FIRM=10000,10 DAY
ANALYSIS DATE: 09-02-92   ECONOMIC LIFE 20 YEARS PREPARED BY: G W SMITH

1. INVESTMENT

A. CONSTRUCTION COST	$	0.
B. SIOH	$	0.
C. DESIGN COST	$	0.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	0.

****** No investment costs; Items 3D1B and 6 should be checked. ******

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ .00	0.	$ 0.	13.68	0.
B. DIST	$ .00	0.	$ 0.	14.64	0.
C. RESID	$ .00	0.	$ 0.	16.00	0.
D. NAT G	$ 5.46	39411.	$ 215184.	17.25	3711925.
E. COAL	$ .00	0.	$ 0.	15.38	0.
F. TOTAL		39411.	$ 215184.		$ 3711925.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -105000.
   (1) DISCOUNT FACTOR (TABLE A)   12.90
   (2) DISCOUNTED SAVING/COST (3A X 3A1) $ -1354500.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ -1354500.

D. PROJECT NON ENERGY QUALIFICATION TEST
   (1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 1224935.
      A IF 3D1 IS = OR > 3C GO TO ITEM 4
      B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)________
      C IF 3D1B IS = > 1 GO TO ITEM 4
      D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 110184.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 2357425.

6. DISCOUNTED SAVINGS RATIO   (SIR)=(5 / 1E)= ******
   (IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED)   SPB=1E/4   .00

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: LPG1
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065
INSTALLATION & LOCATION: FORT GORDON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 7469B LPG STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: FIRM=8500,5 DAY
ANALYSIS DATE: 09-02-92 ECONOMIC LIFE 20 YEARS PREPARED BY: G W SMITH

1. INVESTMENT

A. CONSTRUCTION COST	$	0.
B. SIOH	$	0.
C. DESIGN COST	$	0.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	0.

****** No investment costs; Items 3D1B and 6 should be checked. ******

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ .00	0.	$ 0.	13.68	0.
B. DIST	$ .00	0.	$ 0.	14.64	0.
C. RESID	$ .00	0.	$ 0.	16.00	0.
D. NAT G	$ 5.46	56302.	$ 307409.	17.25	5302804.
E. COAL	$ .00	0.	$ 0.	15.38	0.
F. TOTAL		56302.	$ 307409.		$ 5302804.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -75000.
(1) DISCOUNT FACTOR (TABLE A) 12.90
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -967500.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ -967500.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 1749925.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E)______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 232409.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 4335304.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= ******
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 .00

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: LPG1
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.065
INSTALLATION & LOCATION: FORT GORDON REGION NOS. 4 CENSUS: 3
PROJECT NO. & TITLE: 7469B LPG STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: FIRM=8500,10 DAY
ANALYSIS DATE: 09-02-92 ECONOMIC LIFE 20 YEARS PREPARED BY: G W SMITH

1. INVESTMENT

A. CONSTRUCTION COST	$	0.
B. SIOH	$	0.
C. DESIGN COST	$	0.
D. SALVAGE VALUE COST	-$	0.
E. TOTAL INVESTMENT (1A + 1B + 1C - 1D)	$	0.

****** No investment costs; Items 3D1B and 6 should be checked. ******

2. ENERGY SAVINGS (+) / COST (-)
ANALYSIS DATE ANNUAL SAVINGS, UNIT COST & DISCOUNTED SAVINGS

FUEL	UNIT COST $/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL $ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELECT	$ .00	0.	$ 0.	13.68	0.
B. DIST	$ .00	0.	$ 0.	14.64	0.
C. RESID	$ .00	0.	$ 0.	16.00	0.
D. NAT G	$ 5.46	56302.	$ 307409.	17.25	5302804.
E. COAL	$ .00	0.	$ 0.	15.38	0.
F. TOTAL		56302.	$ 307409.		$ 5302804.

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -150000.
(1) DISCOUNT FACTOR (TABLE A) 12.90
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -1935000.

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4)$ -1935000.

D. PROJECT NON ENERGY QUALIFICATION TEST
(1) 25% MAX NON ENERGY CALC (2F5 X .33) $ 1749925.
A IF 3D1 IS = OR > 3C GO TO ITEM 4
B IF 3D1 IS < 3C CALC SIR = (2F5+3D1)/1E) ______
C IF 3D1B IS = > 1 GO TO ITEM 4
D IF 3D1B IS < 1 PROJECT DOES NOT QUALIFY

4. FIRST YEAR DOLLAR SAVINGS 2F3+3A+(3B1D/(YRS ECONOMIC LIFE))$ 157409.

5. TOTAL NET DISCOUNTED SAVINGS (2F5+3C) $ 3367804.

6. DISCOUNTED SAVINGS RATIO (SIR)=(5 / 1E)= ******
(IF < 1 PROJECT DOES NOT QUALIFY)

7. SIMPLE PAYBACK PERIOD (ESTIMATED) SPB=1E/4 .00

SUBJECT LPG TANK Capacity SHEET NO. 1 OF 4 JOB NO. 7469B

BY GWS DATE 7-31-92 CHKD. BY DATE

Purpose: Determine MAX Fill Capacity on 30,000 gAL STG TANKS

Basis: NFPA 58

1) TABLE 4-5.2.1 MAX Permit Filling Density
2) Table E-3.1.3 Liquid Vol correct FACTOR
3) Equation in Sec E-4.1.2

$$V_t = \frac{L}{G \times F}$$

V_t = % of Container CAPAC. to be FILLED

L = Fill Density

G = Spec. Grav LP-GAS

F = Correct. Factor for Vol @ temp

5) Temp = 40°F — GAS will EXPAND when HEATED

CALCULATION:

① CALC. MAX FILL %

$$V_t = \frac{.45}{(.508)(1.032)} = .858 \ (85\%)$$

② CALC Allowable Fill Volume in 30k gAL Tank

30,000 GAL X 85% = 25,500 GALLONS

Sheet 2 of 4

E-4.1.2 The maximum volume "V," (in percent of container capacity) of an LP-Gas at temperature "t," having a specific gravity "G" and a filling density of "L," is computed by use of the formula:

* $$V_t = \frac{L}{G} \div F, \text{ or } V_t = \frac{L}{G \times F} \text{ where:}$$

V_t = percent of container capacity which may be filled with liquid
L = filling density
G = specific gravity of particular LP-Gas
F = correction factor to correct volume at temperature "t" to 60°F.

EXAMPLE 1: The maximum liquid content, in percent of container capacity, for an aboveground 500 gal water capacity container of an LP-Gas having a specific gravity of 0.550 and at a liquid temperature of 45°F is computed as follows:

From Table 4-5.2.1, L = 0.47, and from Table E-3.1.3, °F = 1.019.

$$\text{Thus } V_{45} = \frac{0.47}{0.550 \times 1.019} = 0.838\ (83\%), \text{ or 415 gallons.}$$

* **EXAMPLE 2:** The maximum liquid content, in percent of container capacity, for an aboveground 30,000 gal water capacity container of LP-Gas having a specific gravity of 0.508 and at a liquid temperature of 80°F is computed as follows:

From Table 4-5.2.1, L = 0.45, and from Table E-3.1.3, °F = 0.967.

$$\text{Thus } V_{80} = \frac{0.45}{0.508 \times 0.967} = 0.915\ (91\%), \text{ or 27,300 gallons.}$$

E-4.2 Alternate Method of Filling Containers.

E-4.2.1 Containers equipped only with fixed maximum level gauges or only with variable liquid level gauges, when temperature determinations are not practical, may be filled with either gauge provided the fixed maximum liquid level gauge is installed, or the variable gauge is set, to indicate the volume equal to the maximum permitted filling density as provided in 4-5.3.3(a). This level is computed on the basis that the liquid temperature will be 40°F for aboveground containers, or 50°F for underground containers.

E-4.2.2 The percentage of container capacity which may be filled with liquid is computed by use of the formula shown in E-4.1.2, substituting the appropriate values as follows:

$$V_t = \frac{L}{G \times F}, \text{ where:}$$

t = the liquid temperature. Assumed to be 40°F for aboveground containers or 50°F for underground containers.

L = the loading density obtained from Table 4-5.2.1 for:

(a) the specific gravity of the LP-Gas to be contained.

(b) the method of installation, aboveground or underground, and if aboveground, then:

(1) for containers of 1,200 gal water capacity or less.

(2) for containers of more than 1,200 gal water capacity.

G = the specific gravity of the LP-Gas to be contained.

F = the correction factor. Obtained from Table E-3.1.3, using G and 40°F for aboveground containers or 50°F for underground containers.

EXAMPLE: The maximum volume of LP-Gas with a specific gravity of 0.550 which may be in a 1,000 gal water capacity aboveground container which is filled by use of a fixed maximum liquid level gauge is computed as follows:

t is 40°F for an aboveground container.

L for 0.550 specific gravity, and an aboveground container of less than 1,200 gal water capacity, from Table 4-5.2.1, is 47 percent.

G is 0.550.

F for 0.550 specific gravity at 40°F from Table E-3.1.3 is 1.025.

$$\text{Thus, } V_{40} = \frac{.47}{0.550 \times 1.025} = 0.834\ (83\%), \text{ or 830 gallons.}$$

E-4.2.3 Percentage values, such as in the example in E-4.2.2, are rounded off to the next lower full percentage point, or to 83 percent in this example.

E-4.3 Location of Fixed Maximum Liquid Level Gauges in Containers.

E-4.3.1 Due to the diversity of fixed liquid gauges, and the many sizes (from DOT cylinders to 120,000 gal ASME vessels) and types (vertical, horizontal, cylindrical and spherical) of containers in which gauges are installed, it is not possible to tabulate the liquid levels such gauges should indicate for the maximum permitted filling densities [*see Table 4-5.2.1 and 4-5.3.3(a)*].

E-4.3.2 The percentage of container capacity which these gauges should indicate is computed by use of the formula in E-4.1.2. The liquid level this gauge should indicate is obtained by applying this percentage to the water capacity of the container in gal (water at 60°F), then using the strapping table for the container (obtained from its manufacturer) to determine the liquid level for this gallonage. If such a table is not available, this liquid level is computed from the internal dimensions of the container, using data from engineering handbooks.

E-4.3.3 The formula of E-4.1.2 is used to determine the maximum LP-Gas liquid content of a container to comply with Table 4-5.2.1 and 4-5.3.3(a), as follows:

$$\text{Volumetric percentage, or } V_t = \frac{L}{G \times F}, \text{ and}$$

$$\text{Volume in Gallons} = V_t \times \text{Container Gallons Water Capacity, or}$$

$$\text{Vol. in Gal. at t} = \frac{\text{L (Table 4-5.2.1)} \times \text{Container Gallons Water Capacity}}{\text{G (Spec. Grav.)} \times \text{F (For G and at temperature t)}}$$

Sheet 3 of 4

Table 4-5.2.1
Maximum Permitted Filling Density

Specific Gravity at 60°F (15.6°C)	Aboveground Containers: 0 to 1200 US Gal (1000 Imp. gal, 4.5 m³) Total Water Cap.	Aboveground Containers: Over 1200 US Gal (1000 Imp. gal, 4.5 m³) Total Water Cap.	Underground Containers all Capacities
.496-.503	41%	44%	45%
.504-.510	42	45	46
.511-.519	43	46	47
.520-.527	44	47	48
.528-.536	45	48	49
.537-.544	46	49	50
.545-.552	47	50	51
.553-.560	48	51	52
.561-.568	49	52	53
.569-.576	50	53	54
.577-.584	51	54	55
.585-.592	52	55	56
.593-.600	53	56	57

permitted filling density and the temperature of the liquid [*see Tables 4-5.2.3(a), (b) and (c)*].

(b) The maximum volume "V_t" (in percent of container capacity) of an LP-Gas at temperature "t," having a specific gravity "G" and a filling density of "L," shall be computed by use of the formula (*see Appendix E-4.1.2 for example*):

$$V_t = \frac{L}{G} \div F, \text{ or } V_t = \frac{L}{G \times F} \text{ where:}$$

V_t = percent of container capacity which may be filled with liquid.

L = filling density.

G = specific gravity of particular LP-Gas.

F = correction factor to correct volume at temperature "t" to 60°F (15.6°C).

4-5.3 Compliance with Maximum Permitted Filling Density Provisions.

4-5.3.1 The maximum permitted filling density for any container, where practical, may be determined by weight.

4-5.3.2 The volumetric method may be used for the following containers if designed and equipped for filling by volume:

(a) DOT specification cylinders of less than 200 lb (91 kg) water capacity which are not subject to DOT jurisdiction (such as, but not limited to, motor fuel containers on vehicles not in interstate commerce or cylinders filled at the installation).

(b) DOT specification cylinders of 200 lb (91 kg) water capacity or more. (*See DOT regulations requiring spot weight checks.*)

(c) Cargo tanks or portable tank containers complying with DOT Specifications MC-330, MC-331 or DOT 51.

(d) ASME and API-ASME containers complying with 2-2.1.3 or 2-2.2.2.

4-5.3.3 When the volumetric method is used, it shall be in accordance with 4-5.3.3(a) through (c).

(a) If a maximum fixed liquid level gauge, or a variable liquid level gauge without liquid volume temperature correction is used, the liquid level indicated by these gauges must be computed on the basis of the maximum permitted filling density when the liquid is at 40°F (4.4°C) for aboveground containers or at 50°F (10°C) for underground containers.

(b) When a variable liquid level gauge is used and the liquid volume is corrected for temperature, the maximum permitted liquid level shall be in accordance with Tables 4-5.2.3(a), (b) and (c).

(c) In the case of containers fabricated after December 31, 1965, with a water capacity of 2,000 gal (7.6 m³) or less and which are filled at consumer sites, gauging shall comply with the following:

(1) The variable gauge shall have been checked for accuracy by comparison with the liquid level indicated by the fixed maximum liquid level gauge.

(2) If the container is to be filled beyond the level indicated by the fixed maximum liquid level gauge, the reading of the variable gauge, adjusted for the error indicated by the check with the fixed maximum liquid level gauge, shall be corrected for the LP-Gas liquid temperature.

4-5.3.4 When containers are to be filled volumetrically by a variable liquid level gauge in accordance with 4-5.3.3(b), provisions shall be made for determining the liquid temperature (*see E-3.1.2*).

Table E-3.1.3

Liquid Volume Correction Factors

Observed Temperature Degrees Fahrenheit	0.500	Propane 0.5079	0.510	0.520	0.530	0.540	0.550	0.560	iso-Butane 0.5631	0.570	0.580	n-Butane 0.5844	0.590
	SPECIFIC GRAVITIES AT 60° F./60° F. — VOLUME CORRECTION FACTORS												
−50	1.160	1.155	1.153	1.146	1.140	1.133	1.127	1.122	1.120	1.116	1.111	1.108	1.106
−45	1.153	1.148	1.146	1.140	1.134	1.128	1.122	1.117	1.115	1.111	1.106	1.103	1.101
−40	1.147	1.142	1.140	1.134	1.128	1.122	1.117	1.111	1.110	1.106	1.101	1.099	1.097
−35	1.140	1.135	1.134	1.128	1.122	1.116	1.112	1.106	1.105	1.101	1.096	1.094	1.092
−30	1.134	1.129	1.128	1.122	1.116	1.111	1.106	1.101	1.100	1.096	1.092	1.090	1.088
−25	1.127	1.122	1.121	1.115	1.110	1.105	1.100	1.095	1.094	1.091	1.087	1.085	1.083
−20	1.120	1.115	1.114	1.109	1.104	1.099	1.095	1.090	1.089	1.086	1.082	1.080	1.079
−15	1.112	1.109	1.107	1.102	1.097	1.093	1.089	1.084	1.083	1.080	1.077	1.075	1.074
−10	1.105	1.102	1.100	1.095	1.091	1.087	1.083	1.079	1.078	1.075	1.072	1.071	1.069
− 5	1.098	1.094	1.094	1.089	1.085	1.081	1.077	1.074	1.073	1.070	1.067	1.066	1.065
0	1.092	1.088	1.088	1.084	1.080	1.076	1.073	1.069	1.068	1.066	1.063	1.062	1.061
2	1.089	1.086	1.085	1.081	1.077	1.074	1.070	1.067	1.066	1.064	1.061	1.060	1.059
4	1.086	1.083	1.082	1.079	1.075	1.071	1.068	1.065	1.064	1.062	1.059	1.058	1.057
6	1.084	1.080	1.080	1.076	1.072	1.069	1.065	1.062	1.061	1.059	1.057	1.055	1.054
8	1.081	1.078	1.077	1.074	1.070	1.066	1.063	1.060	1.059	1.057	1.055	1.053	1.052
10	1.078	1.075	1.074	1.071	1.067	1.064	1.061	1.058	1.057	1.055	1.053	1.051	1.050
12	1.075	1.072	1.071	1.068	1.064	1.061	1.059	1.056	1.055	1.053	1.051	1.049	1.048
14	1.072	1.070	1.069	1.066	1.062	1.059	1.056	1.053	1.053	1.051	1.049	1.047	1.046
16	1.070	1.067	1.066	1.063	1.060	1.056	1.054	1.051	1.050	1.048	1.046	1.045	1.044
18	1.067	1.065	1.064	1.061	1.057	1.054	1.051	1.049	1.048	1.046	1.044	1.043	1.042
20	1.064	1.062	1.061	1.058	1.054	1.051	1.049	1.046	1.046	1.044	1.042	1.041	1.040
22	1.061	1.059	1.058	1.055	1.052	1.049	1.046	1.044	1.044	1.042	1.040	1.039	1.038
24	1.058	1.056	1.055	1.052	1.049	1.046	1.044	1.042	1.042	1.040	1.038	1.037	1.036
26	1.055	1.053	1.052	1.049	1.047	1.044	1.042	1.039	1.039	1.037	1.036	1.036	1.034
28	1.052	1.050	1.049	1.047	1.044	1.041	1.039	1.037	1.037	1.035	1.034	1.034	1.032
30	1.049	1.047	1.046	1.044	1.041	1.039	1.037	1.035	1.035	1.033	1.032	1.032	1.030
32	1.046	1.044	1.043	1.041	1.038	1.036	1.035	1.033	1.033	1.031	1.030	1.030	1.028
34	1.043	1.041	1.040	1.038	1.036	1.034	1.032	1.031	1.030	1.029	1.028	1.028	1.026
36	1.039	1.038	1.037	1.035	1.033	1.031	1.030	1.028	1.028	1.027	1.025	1.025	1.024
38	1.036	1.035	1.034	1.032	1.031	1.029	1.027	1.026	1.025	1.025	1.023	1.023	1.022
40	1.033	1.032	1.031	1.029	1.028	1.026	1.025	1.024	1.023	1.023	1.021	1.021	1.020
42	1.030	1.029	1.028	1.027	1.025	1.024	1.023	1.022	1.021	1.021	1.019	1.019	1.018
44	1.027	1.026	1.025	1.023	1.022	1.021	1.020	1.019	1.019	1.018	1.017	1.017	1.016
46	1.023	1.022	1.022	1.021	1.020	1.018	1.018	1.017	1.016	1.016	1.015	1.015	1.014
48	1.020	1.019	1.019	1.018	1.017	1.016	1.015	1.014	1.014	1.013	1.013	1.013	1.012
50	1.017	1.016	1.016	1.015	1.014	1.013	1.013	1.012	1.012	1.011	1.011	1.011	1.010
52	1.014	1.013	1.012	1.012	1.011	1.010	1.010	1.009	1.009	1.009	1.009	1.009	1.008
54	1.010	1.010	1.009	1.009	1.008	1.008	1.007	1.007	1.007	1.007	1.006	1.006	1.006
56	1.007	1.007	1.006	1.006	1.005	1.005	1.005	1.005	1.005	1.005	1.004	1.004	1.004
58	1.003	1.003	1.003	1.003	1.003	1.003	1.002	1.002	1.002	1.002	1.002	1.002	1.002
60	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
62	0.997	0.997	0.997	0.997	0.997	0.997	0.997	0.998	0.998	0.998	0.998	0.998	0.998
64	0.993	0.993	0.994	0.994	0.994	0.994	0.995	0.995	0.995	0.995	0.996	0.996	0.996
66	0.990	0.990	0.990	0.990	0.991	0.992	0.992	0.993	0.993	0.993	0.993	0.993	0.993
68	0.986	0.986	0.987	0.987	0.988	0.989	0.990	0.990	0.990	0.990	0.991	0.991	0.991
70	0.983	0.983	0.984	0.984	0.985	0.986	0.987	0.988	0.988	0.988	0.989	0.989	0.989
72	0.979	0.980	0.981	0.981	0.982	0.983	0.984	0.985	0.986	0.986	0.987	0.987	0.987
74	0.976	0.976	0.977	0.978	0.980	0.980	0.982	0.983	0.983	0.984	0.985	0.985	0.985
76	0.972	0.973	0.974	0.975	0.977	0.978	0.979	0.980	0.981	0.981	0.982	0.982	0.983
78	0.969	0.970	0.970	0.972	0.974	0.975	0.977	0.978	0.978	0.979	0.980	0.980	0.981
80	0.965	0.967	0.967	0.969	0.971	0.972	0.974	0.975	0.976	0.977	0.978	0.978	0.979
82	0.961	0.963	0.963	0.966	0.968	0.969	0.971	0.972	0.973	0.974	0.976	0.976	0.977
84	0.957	0.959	0.960	0.962	0.965	0.966	0.968	0.970	0.971	0.972	0.974	0.974	0.975
86	0.954	0.956	0.956	0.959	0.961	0.964	0.966	0.967	0.968	0.969	0.971	0.971	0.972
88	0.950	0.952	0.953	0.955	0.958	0.961	0.963	0.965	0.966	0.967	0.969	0.969	0.970
90	0.946	0.949	0.949	0.952	0.955	0.958	0.960	0.962	0.963	0.964	0.967	0.967	0.968
92	0.942	0.945	0.946	0.949	0.952	0.955	0.957	0.959	0.960	0.962	0.964	0.965	0.966
94	0.938	0.941	0.942	0.946	0.949	0.952	0.954	0.957	0.958	0.959	0.962	0.962	0.964
96	0.935	0.938	0.939	0.942	0.946	0.949	0.952	0.954	0.955	0.957	0.959	0.960	0.961
98	0.931	0.934	0.935	0.939	0.943	0.946	0.949	0.952	0.953	0.954	0.957	0.957	0.959
100	0.927	0.930	0.932	0.936	0.940	0.943	0.946	0.949	0.950	0.952	0.954	0.955	0.957
105	0.917	0.920	0.923	0.927	0.931	0.935	0.939	0.943	0.943	0.946	0.949	0.949	0.951
110	0.907	0.911	0.913	0.918	0.923	0.927	0.932	0.936	0.937	0.939	0.943	0.944	0.946
115	0.897	0.902	0.904	0.909	0.915	0.920	0.925	0.930	0.930	0.933	0.937	0.938	0.940
120	0.887	0.892	0.894	0.900	0.907	0.912	0.918	0.923	0.924	0.927	0.931	0.932	0.934
125	0.876	0.881	0.884	0.890	0.898	0.903	0.909	0.916	0.916	0.920	0.925	0.927	0.928
130	0.865	0.871	0.873	0.880	0.888	0.895	0.901	0.908	0.909	0.913	0.918	0.921	0.923
135	0.854	0.861	0.863	0.871	0.879	0.887	0.894	0.901	0.902	0.907	0.912	0.914	0.916
140	0.842	0.850	0.852	0.861	0.870	0.879	0.886	0.893	0.895	0.900	0.905	0.907	0.910

SIMONS

CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT LPG PIPELINE PRESSURE DROP SHEET NO. 1 OF 26 JOB NO. 7469B

BY GWS DATE CHKD. BY DATE 7-31-92

PURPOSE: DETURMINE ESTIMATED ΔP + Final pressure OF Propane/Air Flow through an 8" PipeLine AT VARIOUS INITIAL PRESSURES.

BASIS:

1. From point to point press. drop calcs AT 150 psig → $\Delta P = 6.53$
2. MASS FLOW of Propane Air IS CONSTANT FOR A GIVEN HEAT LOAD + does not change WITH Pressure
3. Supercompressability + deviation from perfect gas law is insignificant (< 3% DEVIATION)
4. EQUATIONS:

$$\Delta P = .000336 \frac{f W^2}{d^5 \rho}$$ Darcy formula

$$\rho = \frac{(2.70)(P+15)(SG)}{T+460}$$ where $SG = 1.28$, $T = 70°F$

ΔP = Press Drop
f = frict. factor
W = MASS flow
d = inside Pipe Diam.
ρ = density

5. Reference CRANE Manual 410

CALCULATIONS:

1. Rewrite Darcy Formula TO SOLVE FOR ΔP_2

$$\frac{\Delta P_1}{\Delta P_2} = \frac{\rho_2}{\rho_1} \longrightarrow \Delta P_2 = \Delta P_1 \frac{\rho_1}{\rho_2}$$

THE Above IS TRUE SINCE f, W, d, ρ ARE CONSTANT

2. Substitute KNOWN VALUES

$$\Delta P_2 = (6.53 \text{ PSIG}) \frac{1.0759}{\rho_2}$$ AT 150 PSIG

SIMONS

CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT LPG Pipeline Press. Drop SHEET NO. 2 OF 26 JOB NO. 7469B

BY GWS DATE CHKD. BY DATE 7-31-92

Comparison of Pressure Drops

P_1	ρ_{LPG}	ΔP	P_2	
150 PSIG	1.0759 lb/CF	6.53 PSIG	143 PSIG	
125	.910	7.7	117	
100	.748	9.4	91	
75	.585	12.0	63	← USE FOR COST ESTIMATE SIZE
60	.489	14.4	46	
50	.325	21.7	28	

P_1 = Pressure at Vaporizer

ρ_{LPG} = Density of LPG at P_1

ΔP = Calculated Press. Drop at P_1

P_2 = Min. system Pressure, $P_1 - \Delta P$

T = 70 °F

SUBJECT LPG Pipeline Pressure Drop SHEET NO. 3 OF 26 JOB NO. 7469

BY LEN SKIBICKI DATE 7/29/92 CHKD. BY DATE 7-29-9?

PRESSURE DROP CHECK POINTS

POINT	LIN. FT. (l)	TOTAL SCFM FLOW	P_1	ΔP	P_2
# 3	10050	2568.13	150	3.29	146.71
# 5	1220	2290.46	146.71	.326	146.38
# 7	4350	2149.51	146.38	1.022	145.36
# 8	2000	1890.61	145.36	.366	144.99
# 11	4460	1800.58	144.99	.767	144.22
# 12	2300	1780.93	144.22	.389	143.83
# 13	1250	1375.30	143.83	.143	143.69
# 14	2300	1169.5	143.69	.172	143.52
# 15	2550	970.2	143.52	.05	143.47

TOTAL PRESSURE DROP

150 - 143.47 = 6.53

SIMONS

CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT LPG Pipeline Pressure Drop SHEET NO. 4 OF 26 JOB NO. 746A

BY ______ DATE ______ CHKD. BY ______ DATE ______

1" = 40'-0"

	DISTANCE	GAS USE @ SECOND POINT (#)	
LPG - BRANCH (TIE-IN)	- 2000 FT.		
TIE-IN - 1ST BRANCH	- 1000	4.5 SCFM	(405 MBTU)
#1 - #2	- 4150	5.67 SCFM	(570 MBTU)
#2 - #3	- 2900	267.5 SCFM MDES? HALLS?	(24080 MBTU)
#3 - #4	- 1100	2.1 SCFM	(185 MBTU)
#4 - #5	- 120	138.85 SCFM	(12497)
#5 - #6	- 3250	NO USERS	
#6 - #7	- 1100	253.9 SCFM	(23300 MBTU)
#7 - #8	- 2000	74.2 SCFM	(6679 MBTU)
#8 - #9	- 2280	2.5 SCFM	(225 MBTU)
#9 - #10	- 1780	13.33 SCFM	(1200 MBTU)
#10 - #11	- 400	19.65 SCFM	(1769 MBTU)
#11 - #12	- 2300	405.63 SCFM	(36507 MBTU)
#12 - #13	- 1250	205.8 SCFM	(18522 MBTU)
#13 - #14	- 2300	199.3 SCFM	(17934 MBTU)
#14 - #15	- 2550	970.2 SCFM	(87318 MBTU)
	30480	2568.13 SCFM	231,132 MBTU

MILE = 5280 FT.

$$\ell = \frac{30480}{5280} = 5.773 \text{ MILES}$$

EQUATIONS & CONDITIONS

$\Delta P_{100} = .000336 \times \frac{f W^2}{d^5 \rho}$ (CRANE PAPER NO. 410, PG. 3-20)

$W = .0764\, q_h' S_g$ (FLOW RATE, #/HR) (CRANE PG. 3-20)

$\rho = \frac{2.70\, P' S_g}{T}$ (WT. DENSITY, lbs/FT³) (CRANE PG. A-10)

f (FRICTION FACTOR) (CRANE NOMOGRAPH, PG. 3-19)
(VALUE OF μ = CRANE PG. A-5)

$S_g = 1.28$ (55% PROPANE; 45% AIR)

HEAT CONTENT = 1500 BTU/SCF

TEMP. - 70° F

PIPE - 8" SCH. 40 (7.981 I.D.)

P = 150 PSIG (PRESSURE AT LPG AS BASIS FOR STUDY)

Sheet 6 of 26

Pressure Drop in Compressible Flow Lines

The pressure drop of flowing compressible fluids can be calculated from the Darcy formula below, or, from the nomograph on the opposite page. The nomograph is a graphical solution of the formula.

$$\Delta P_{100} = 0.000\,336 \frac{f\,W^2 \overline{V}}{d^5} = 0.000\,336 \frac{f\,W^2}{d^5 \rho}$$

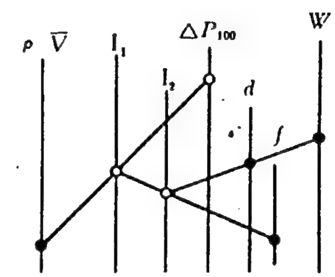
$$\Delta P_{100} = 0.000\,001\,959 \frac{f\,(q'_h)^2\,S_g^2}{d^5\,\rho}$$

(For values of d, see pages B-16 to B-19)

When the flow rate is given in cubic feet per hour at standard conditions (q'_h), use the following equation or the nomograph on page B-2 to convert to pounds per hour (W).

$$W = 0.0764\,q'_h\,S_g$$

Air: For pressure drop, in pounds per square inch per 100 feet of Schedule 40 pipe, for air at 100 psig and 60 F, see page B-15.



Example 1

Given: Steam at 600 psig and 850 F flows through a 4-inch Schedule 80 steel pipe at a rate of 30,000 pounds per hour.

Find: The pressure drop per 100 feet of pipe.

Solution:

1. $d = 3.826$ .... page B-17
2. $\mu = 0.029$ .... page A-2
3. $f = 0.017$ .... page 3-19
4. $\overline{V} = 1.22$ .... page 3-17 or A-17

	Connect		Read
5.	$W = 30\,000$	$d = 3.826$	Index 2
6.	Index 2	$f = 0.017$	Index 1
7.	Index 1	$\overline{V} = 1.22$	$\Delta P_{100} = 7.5$

Example 2

Given: Natural gas at 250 psig and 60 F flows through an 8-inch Schedule 40 pipe at a rate of 1,200,000 standard cubic feet per hour; its specific gravity is 0.75.

Find: The flow rate in pounds per hour and the pressure drop per 100 feet of pipe.

Solution:

1. $W = 69\,000$ .... using $S_g = 0.75$; page B-2
2. $\mu = 0.011$ .... page A-5
3. $f = 0.014$ .... page 3-19
4. $\rho = 1.03$ .... page A-10

	Connect		Read
5.	$W = 69\,000$	8″ Sched 40 pipe	Index 2
6.	Index 2	$f = 0.014$	Index 1
7.	Index 1	$\rho = 1.03$	$\Delta P_{100} = 0.68$

Sheet 7 of 26

Viscosity of Gases and Vapors

The curves for hydrocarbon vapors and natural gases in the chart at the upper right are taken from Maxwell[15]; the curves for all other gases (except helium [7]) in the chart are based upon Sutherland's formula, as follows:

$$\mu = \mu_0 \left(\frac{0.555\ T_0 + C}{0.555\ T + C}\right)\left(\frac{T}{T_0}\right)^{3/2}$$

where:

μ = viscosity, in centipoise at temperature T.

μ_0 = viscosity, in centipoise at temperature T_0.

T = absolute temperature, in degrees Rankine (460 + deg. F) for which viscosity is desired.

T_0 = absolute temperature, in degrees Rankine, for which viscosity is known.

C = Sutherland's constant.

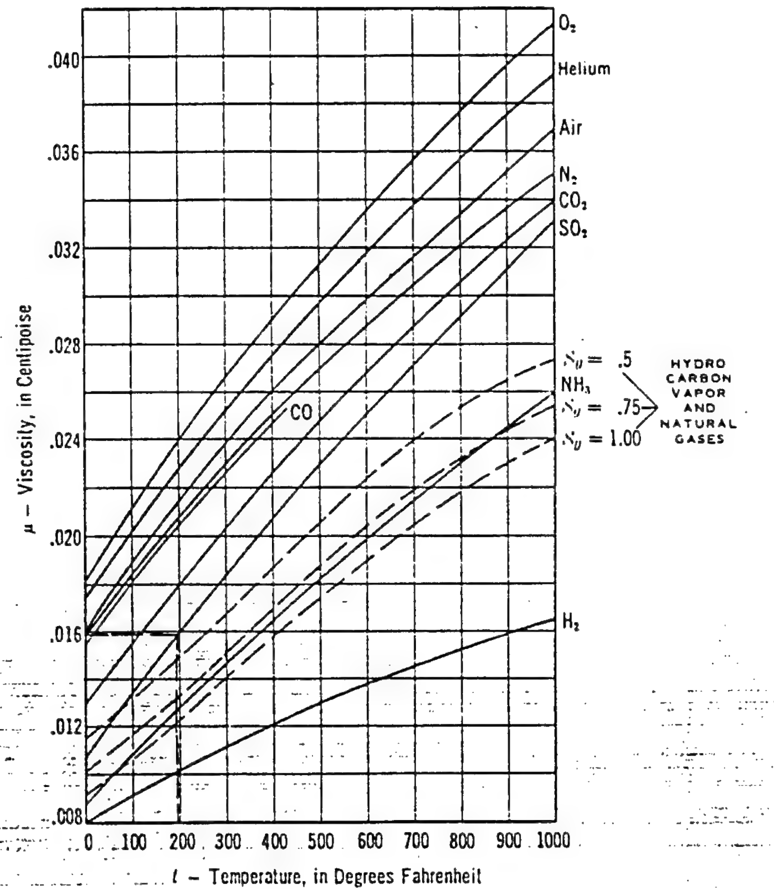
Note: The variation of viscosity with pressure is small for most gases. For gases given on this page, the correction of viscosity for pressure is less than 10 per cent for pressures up to 500 pounds per square inch.

Fluid	Approximate Values of "C"
O_2	127
Air	120
N_2	111
CO_2	240
CO	118
SO_2	416
NH_3	370
H_2	72

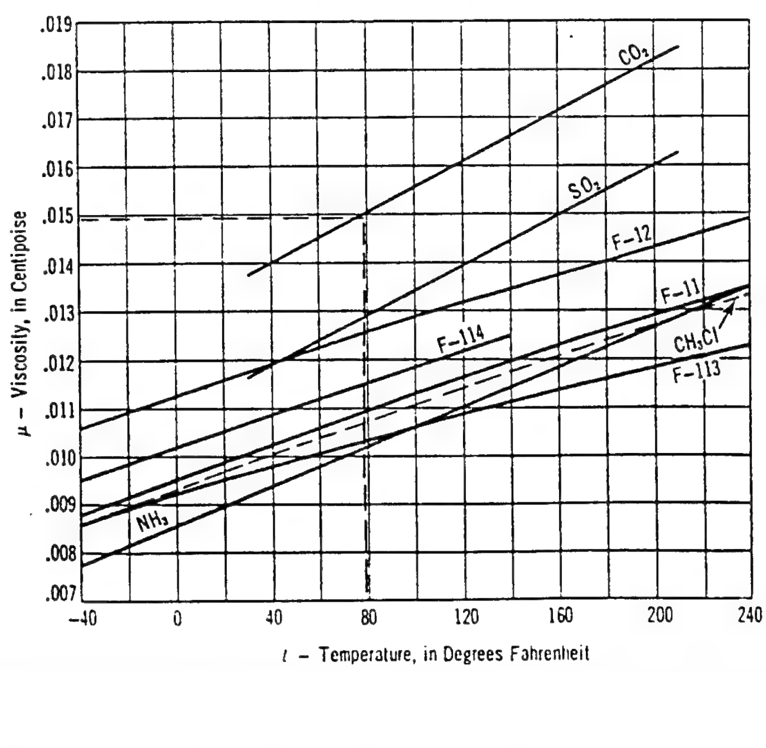
Upper chart example: The viscosity of sulphur dioxide gas (SO_2) at 200 F is 0.016 centipoise.

Lower chart example: The viscosity of carbon dioxide gas (CO_2) at about 80 F is 0.015 centipoise.

Viscosity of Various Gases



Viscosity of Refrigerant Vapors[11]
(saturated and superheated vapors)



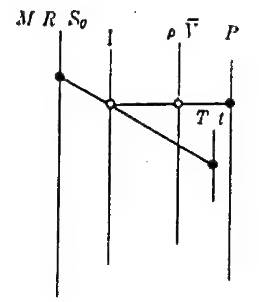
Sheet 8 of 26

Weight Density and Specific Volume Of Gases and Vapors

The chart on page A-11 is based on the formula:

$$\rho = \frac{144\, P'}{RT} = \frac{MP'}{10.72\, T} = \frac{2.70\, P'\, S_g}{T}$$

where: $P' = 14.7 + P$



Problem: What is the density of dry CH_4 if the temperature is 100 F and the gauge pressure is 15 pounds per square inch?

Solution: Refer to the table on page A-8 for molecular weight, specific gravity, or individual gas constant. Connect 96.4 of the *R* scale with 100 on the temperature scale, *t*, and mark the intersection with the index scale. Connect this point with 15 on the pressure scale, *P*. Read the answer, 0.08 pounds per cubic foot, on the weight density scale ρ.

Weight Density of Air

Weight Density of Air, in Pounds per Cubic Foot For Gauge Pressures Indicated (Based on an atmospheric pressure of 14.696 and a molecular weight of 28.97)

Air Temp. Deg F.	0 psi	5 psi	10 psi	20 psi	30 psi	40 psi	50 psi	60 psi	70 psi	80 psi	90 psi	100 psi	110 psi	120 psi	130 psi	140 psi	150 psi
30°	.0811	.1087	.1363	.1915	.247	.302	.357	.412	.467	.522	.578	.633	.688	.743	.798	.853	.909
40	.0795	.1065	.1335	.1876	.242	.295	.350	.404	.458	.512	.566	.620	.674	.728	.782	.836	.890
50	.0782	.1048	.1314	.1846	.238	.291	.344	.397	.451	.504	.557	.610	.663	.717	.770	.823	.876
60	.0764	.1024	.1284	.1804	.232	.284	.336	.388	.440	.492	.544	.596	.648	.700	.752	.804	.856
70	.0750	.1005	.1260	.1770	.228	.279	.330	.381	.432	.483	.534	.585	.636	.687	.738	.789	.840
80	.0736	.0986	.1236	.1737	.224	.274	.324	.374	.424	.474	.524	.574	.624	.674	.724	.774	.824
90	.0722	.0968	.1214	.1705	.220	.269	.318	.367	.416	.465	.515	.564	.613	.662	.711	.760	.809
100	.0709	.0951	.1192	.1675	.216	.264	.312	.361	.409	.457	.505	.554	.602	.650	.698	.747	.795
110	.0697	.0934	.1171	.1645	.212	.259	.307	.354	.402	.449	.497	.544	.591	.639	.686	.734	.781
120	.0685	.0918	.1151	.1617	.208	.255	.302	.348	.395	.441	.488	.535	.581	.628	.674	.721	.768
130	.0673	.0902	.1131	.1590	.205	.251	.296	.342	.388	.434	.480	.525	.571	.617	.663	.709	.755
140	.0662	.0887	.1113	.1563	.201	.246	.291	.337	.382	.427	.472	.517	.562	.607	.652	.697	.742
150	.0651	.0873	.1094	.1537	.1981	.242	.287	.331	.375	.420	.464	.508	.553	.597	.641	.686	.730
175	.0626	.0834	.1051	.1477	.1903	.233	.275	.318	.361	.403	.446	.488	.531	.573	.616	.659	.701
200	.0602	.0807	.1011	.1421	.1831	.224	.265	.306	.347	.388	.429	.470	.511	.552	.593	.634	.675
225	.0580	.0777	.0974	.1369	.1764	.216	.255	.295	.334	.374	.413	.453	.492	.531	.571	.610	.650
250	.0559	.0750	.0940	.1321	.1702	.208	.246	.284	.322	.361	.399	.437	.475	.513	.551	.589	.627
275	.0540	.0724	.0908	.1276	.1644	.201	.238	.275	.311	.348	.385	.422	.459	.495	.532	.569	.606
300	.0523	.0700	.0878	.1234	.1590	.1945	.230	.266	.301	.337	.372	.408	.443	.479	.515	.550	.586
350	.0490	.0657	.0824	.1158	.1491	.1825	.216	.249	.283	.316	.349	.383	.416	.449	.483	.516	.550
400	.0462	.0619	.0776	.1090	.1405	.1719	.203	.235	.266	.298	.329	.360	.392	.423	.455	.486	.518
450	.0436	.0585	.0733	.1030	.1327	.1624	.1921	.222	.252	.281	.311	.341	.370	.400	.430	.459	.489
500	.0414	.0555	.0695	.0977	.1258	.1540	.1821	.210	.238	.267	.295	.323	.351	.379	.407	.436	.464
550	.0393	.0527	.0661	.0928	.1196	.1464	.1731	.1999	.227	.253	.280	.307	.334	.360	.387	.414	.441
600	.0375	.0502	.0630	.0885	.1140	.1395	.1649	.1904	.216	.241	.267	.292	.318	.343	.369	.394	.420

Air Temp. Deg F.	175 psi	200 psi	225 psi	250 psi	300 psi	400 psi	500 psi	600 psi	700 psi	800 psi	900 psi	1000 psi
30°	1.047	1.185	1.323	1.460	1.736	2.29	2.84	3.39	3.94	4.49	5.05	5.60
40	1.026	1.161	1.296	1.431	1.702	2.24	2.78	3.32	3.86	4.40	4.95	5.49
50	1.009	1.142	1.275	1.408	1.674	2.21	2.74	3.27	3.80	4.33	4.87	5.40
60	.986	1.116	1.246	1.376	1.636	2.16	2.68	3.20	3.72	4.24	4.76	5.28
70	.968	1.095	1.223	1.350	1.605	2.12	2.63	3.14	3.65	4.16	4.67	5.18
80	.950	1.075	1.200	1.325	1.575	2.08	2.58	3.08	3.58	4.08	4.58	5.08
90	.932	1.055	1.178	1.301	1.547	2.04	2.53	3.02	3.51	4.00	4.50	4.99
100	.916	1.036	1.157	1.278	1.519	2.00	2.48	2.97	3.45	3.93	4.42	4.90
110	.900	1.018	1.137	1.255	1.492	1.967	2.44	2.92	3.39	3.86	4.34	4.81
120	.884	1.001	1.117	1.234	1.467	1.933	2.40	2.86	3.33	3.80	4.26	4.73
130	.869	.984	1.098	1.213	1.442	1.900	2.36	2.82	3.27	3.73	4.19	4.65
140	.855	.967	1.080	1.193	1.418	1.868	2.32	2.77	3.22	3.67	4.12	4.57
150	.841	.951	1.062	1.173	1.395	1.838	2.28	2.72	3.17	3.61	4.05	4.50
175	.807	.914	1.020	1.127	1.340	1.765	2.19	2.62	3.04	3.47	3.89	4.32
200	.777	.879	.982	1.084	1.289	1.698	2.11	2.52	2.93	3.34	3.75	4.16
225	.749	.847	.946	1.044	1.242	1.636	2.03	2.43	2.82	3.21	3.61	4.00
250	.722	.817	.913	1.088	1.198	1.579	1.959	2.34	2.72	3.10	3.48	3.86
275	.698	.790	.881	.973	1.157	1.525	1.893	2.26	2.63	3.00	3.36	3.73
300	.675	.764	.852	.941	1.119	1.475	1.830	2.19	2.54	2.90	3.25	3.61
350	.633	.716	.800	.883	1.050	1.384	1.717	2.05	2.38	2.72	3.05	3.39
400	.596	.675	.753	.832	.989	1.303	1.618	1.932	2.25	2.56	2.87	3.19
450	.563	.638	.712	.786	.934	1.232	1.529	1.826	2.12	2.42	2.72	3.01
500	.534	.604	.675	.745	.886	1.167	1.449	1.731	2.01	2.29	2.58	2.86
550	.508	.575	.641	.708	.842	1.110	1.377	1.645	1.912	2.18	2.45	2.72
600	.484	.547	.611	.675	.802	1.057	1.312	1.567	1.822	2.08	2.33	2.59

Air Density Table

The table at the left is calculated for the perfect gas law shown at the top of the page. Correction for supercompressibility, the deviation from the perfect gas law, would be less than three percent and has not been applied.

The weight density of gases other than air can be determined from this table by multiplying the density listed for air by the specific gravity of the gas relative to air, as listed in the tables on page A-8.

SIMONS

CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT LPG Pipeline Pressure Drop SHEET NO. 9 OF 26 JOB NO. 7469

BY ______ DATE ______ CHKD. BY ______ DATE ______

ΔP To Point #3

$$\Delta P_{100} = .000336 \frac{f W^2}{d^5 \rho}$$

$$= .000336 \frac{.015 \times 15068.55^2}{7.981^5 \times 1.076}$$

$$= .000336 \times \frac{3405917.98}{34841.66}$$

$$\Delta P_{100} = .0328$$

$$W = .0764 \, q'_h S_g$$

$$= .0764 \times 154087.8 \times 1.28$$

$$= 15068.55$$

$f = .015$ ($\mu = .009$) (NOMOGRAPH)

$$\rho = \frac{2.70 P' S_g}{T} = \frac{2.7 \times 165 \times 1.28}{460+70}$$

(ASSUME 150 PSIG AS BASE PRESSURE)

$$\rho = 1.076$$

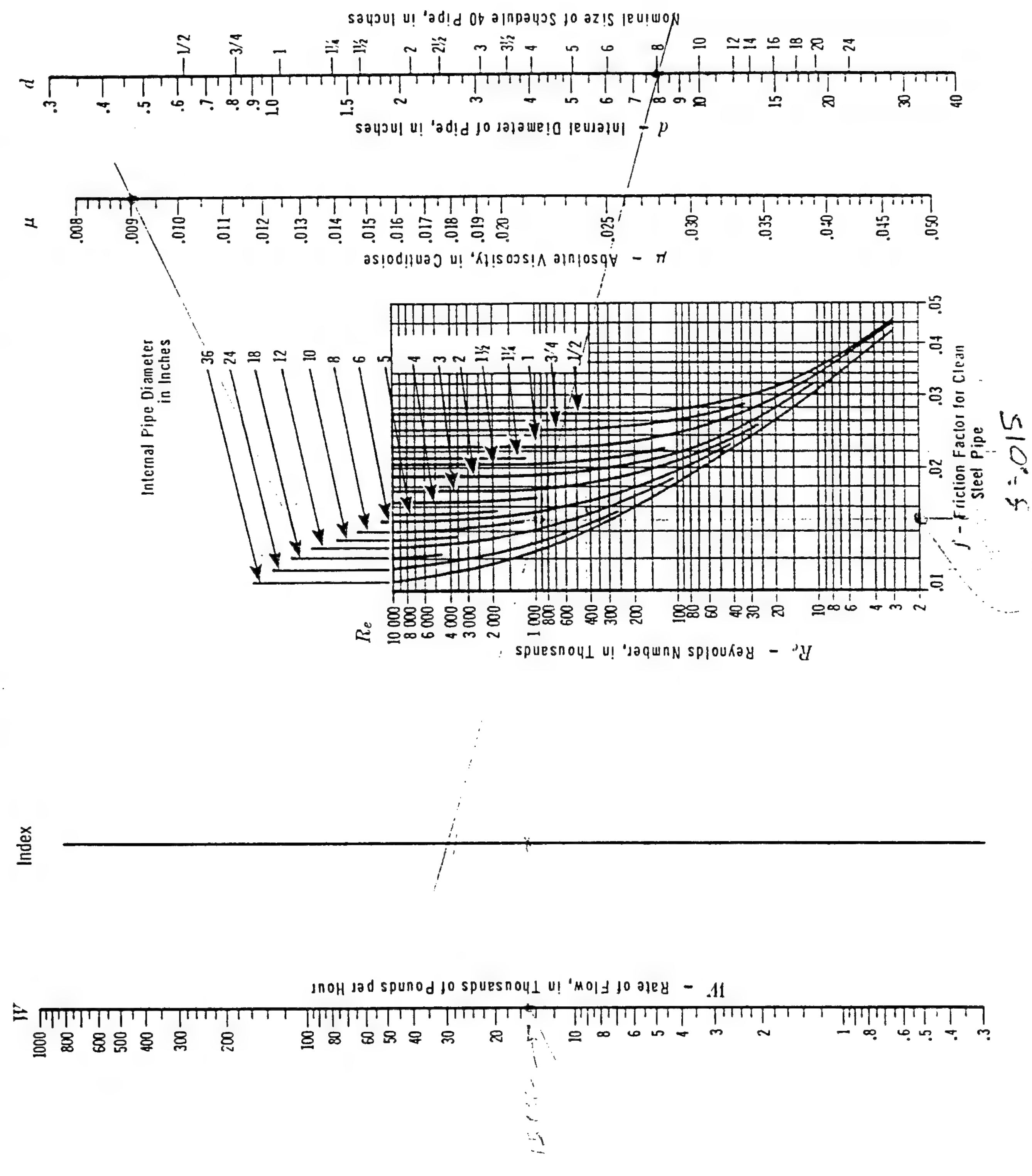
$$\Delta P_{TOT} = \Delta P_{100} \times \frac{l}{100} = .0328 \times 100.5 = 3.29 \text{ PSIG}$$

2469

Reynolds Number for Compressible Flow
Friction Factor for Clean Steel Pipe

ΔP To #3

Sheet 10 of 26



ΔP TO POINT #5

$$\Delta P_{100} = .000336 \frac{f W^2}{d^5 \rho}$$

$$= .000336 \frac{.015 \times 13439.32^2}{7.981^5 \times 1.054}$$

$$= .000336 \times \frac{2709229.83}{34129.28}$$

$$\Delta P_{100} = .0267$$

$$W = .0764\ Q_h'\ S_g$$

$$= .0764 \times 137427.6 \times 1.28$$

$$= 13439.32$$

$f = .015$ ($\mu = .009$) (NOMOGRAPH)

$$\rho = \frac{2.70\ P'\ S_g}{T} = \frac{2.7 \times (146.71 + 15) \times 1.28}{460 + 70}$$

$$\rho = 1.054$$

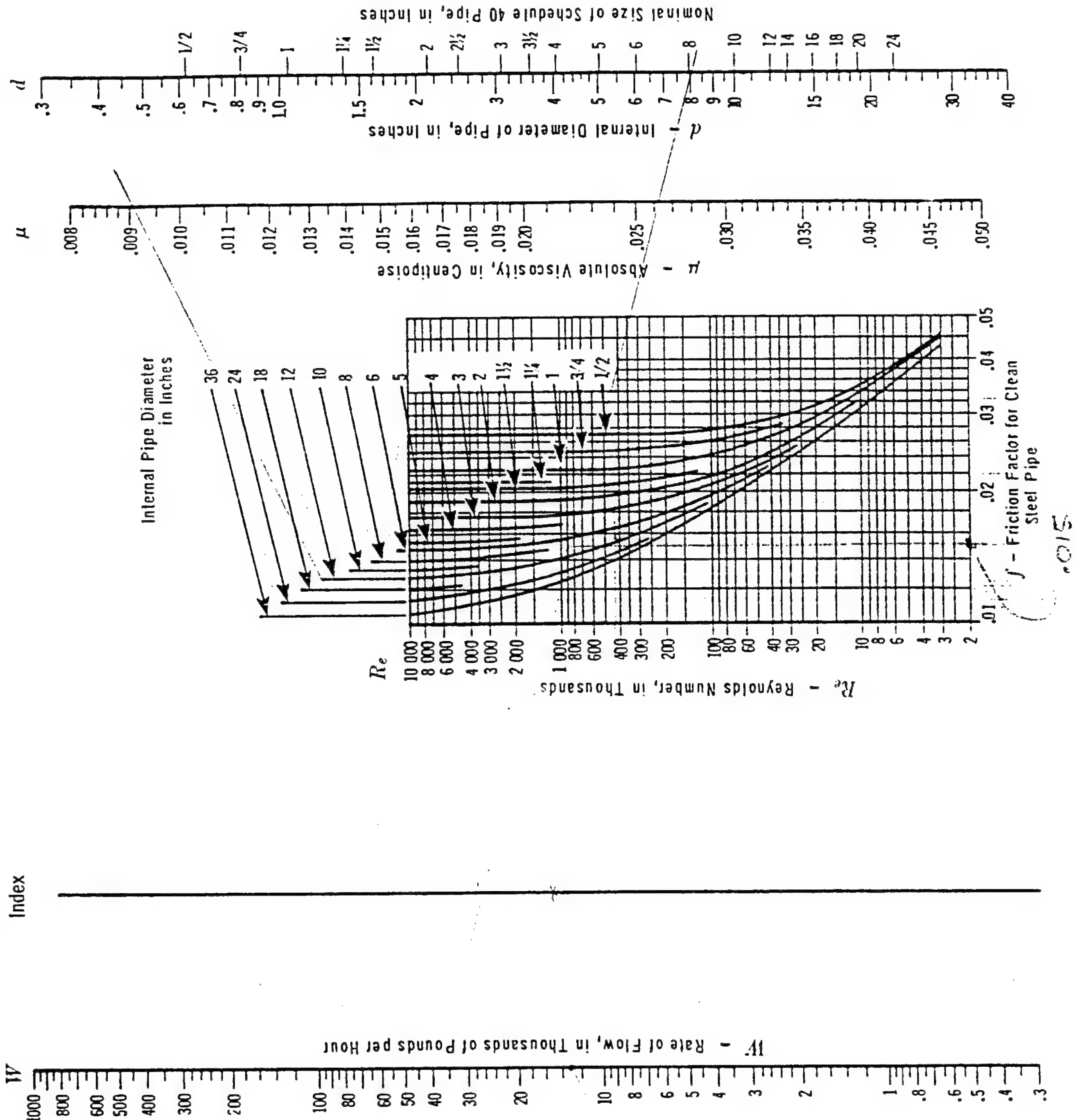
$$\Delta P_{TOT} = \Delta P_{100} \times \frac{L}{100} = .0267 \times 12.2 = .326 \text{ PSIG}$$

Sheet 12 of 26

7469

Reynolds Number for Compressible Flow
Friction Factor for Clean Steel Pipe

ΔP CALC. FOR PT. #5



SIMONS CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT LPG Pipeline Pressure Drop SHEET NO. 13 OF 26 JOB NO. 746

BY ______ DATE ______ CHKD. BY ______ DATE ______

ΔP TO POINT #7

$$\Delta P_{100} = .000336 \frac{f W^2}{d^5 \rho}$$

$$= .000336 \frac{.015 \times 12612.29^2}{7.981^5 \times 1.052}$$

$$\Delta P_{100} = .0235$$

$$W = .0764\, q_h'\, S_g$$

$$= .0764 \times 128970.6 \times 1.28$$

$$= 12612.29$$

$f = .015$ ($\mu = .009$) (NOMOGRAPH)

$$\rho = \frac{2.7\, P'\, S_g}{T} = \frac{2.7 \times (146.38 + 15) \times 1.28}{460 + 70}$$

$$\rho = 1.052$$

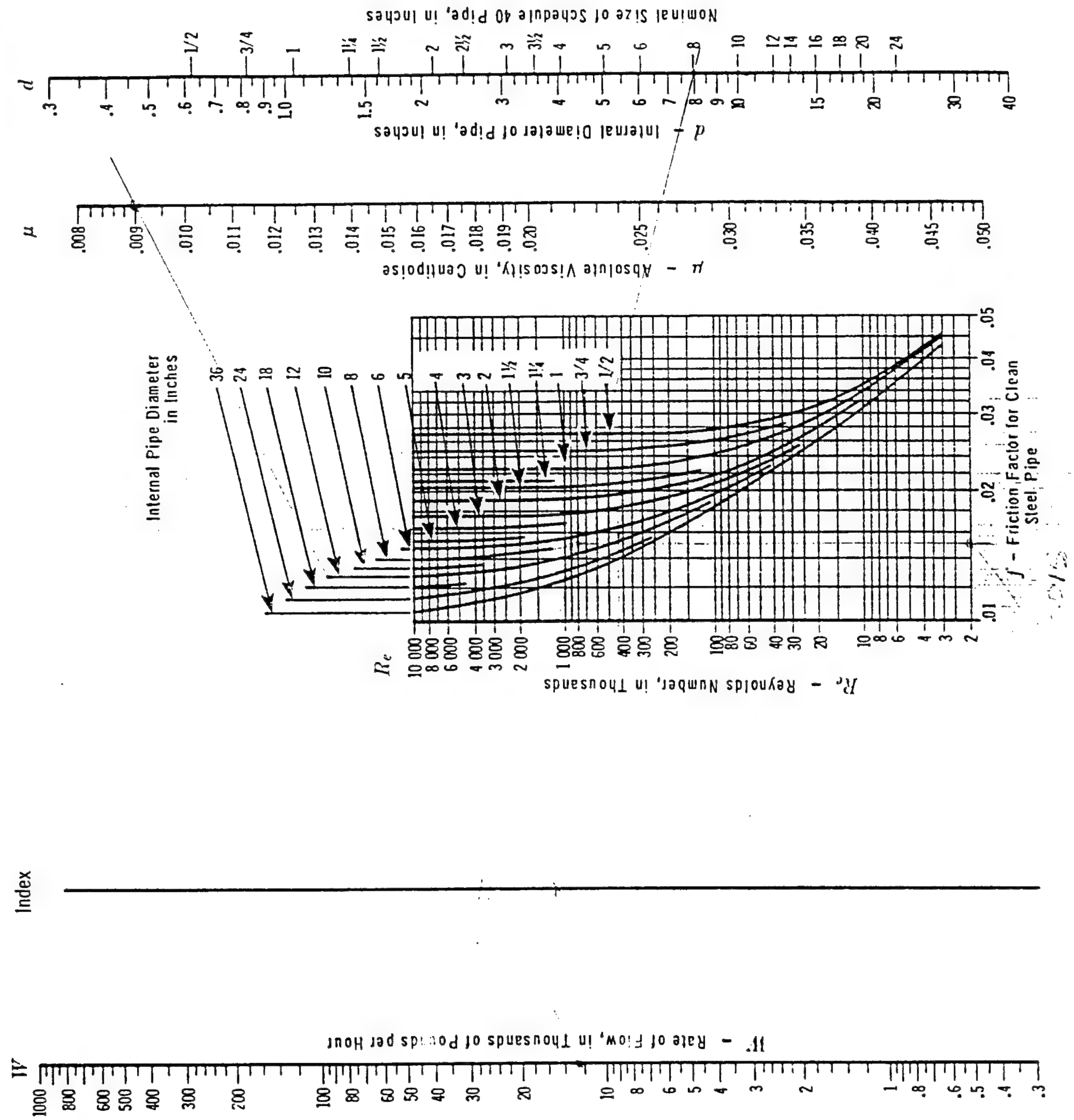
$$\Delta P_{TOT} = \Delta P_{100} \times \frac{l}{100} = .0235 \times 43.5 = 1.022 \text{ PSIG}$$

Sheet 14 of 26

7469

Reynolds Number for Compressible Flow
Friction Factor for Clean Steel Pipe

AP Calc For Run #7



CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT LPG Pipeline Pressure Drop SHEET NO. 15 OF 26 JOB NO. 7469

BY ______ DATE ______ CHKD. BY ______ DATE ______

ΔP To Point #8

$$\Delta P_{100} = .000336 \frac{f W^2}{d^5 \rho}$$

$$= .000336 \frac{.015 \times 11093.19^2}{7.981^5 \times 1.046}$$

$$\Delta P_{100} = .0183$$

$$W = .0764\, q_h'\, S_g$$

$$= .0764 \times 113436.6 \times 1.28$$

$$= 11093.19$$

$f = .015$ $(\mu = .009)$ (NOMOGRAPH)

$$\rho = \frac{2.7\, P' S_g}{T} = \frac{2.7 \times (145.36 + 15) \times 1.28}{460 + 70}$$

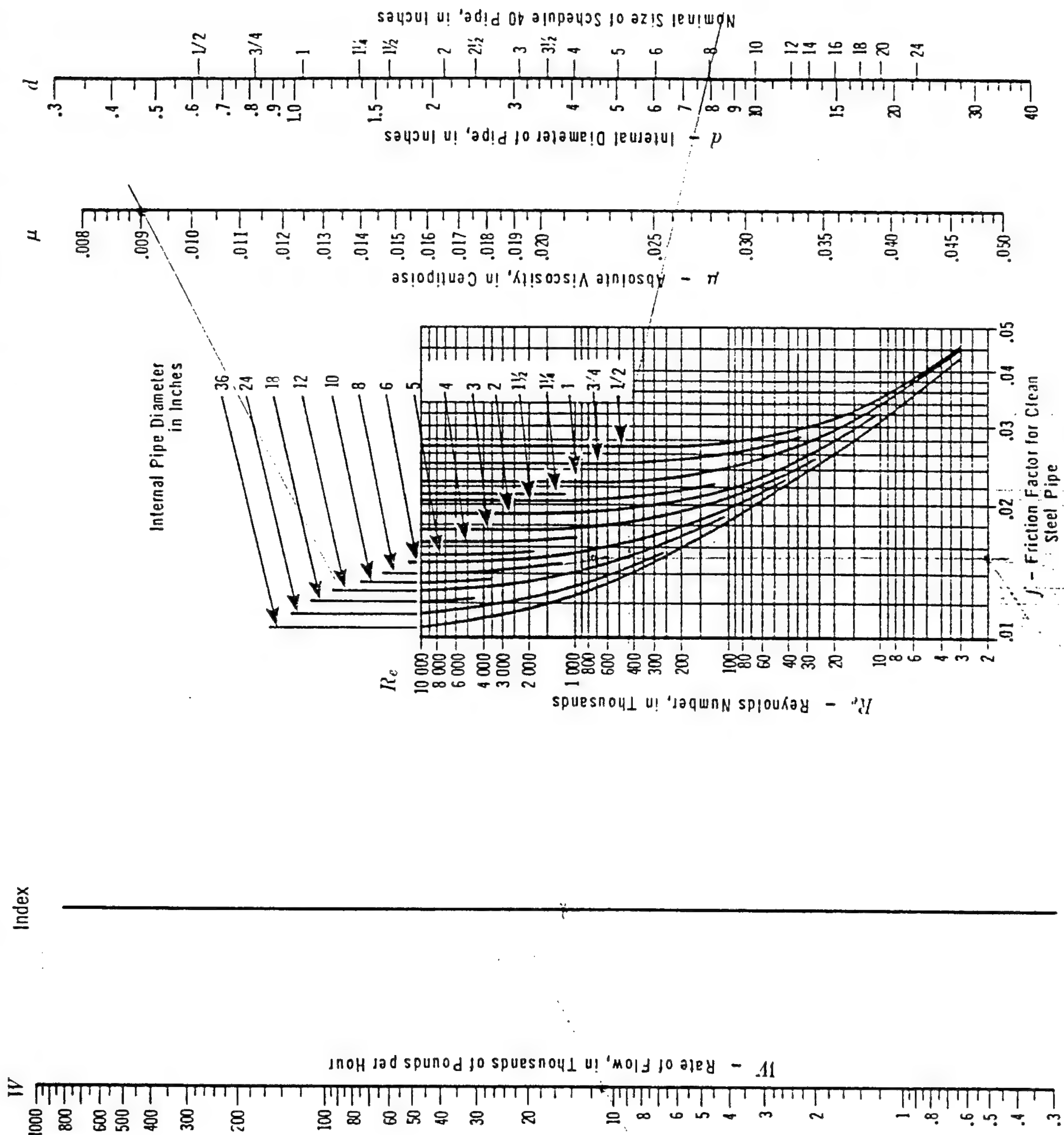
$$\rho = 1.046$$

$$\Delta P_{TOT} = \Delta P_{100} \times \frac{l}{100} = .0183 \times 20 = .366 \text{ PSIG}$$

Sheet 16 of 26
7464

Reynolds Number for Compressible Flow
Friction Factor for Clean Steel Pipe

ΔP CALC FIG POINT #5



ΔP TO POINT #11

$$\Delta P_{100} = .000336 \frac{f W^2}{d^5 \rho}$$

$$= .000336 \frac{.0155 \times 10564.94^2}{7.981^5 \times 1.043}$$

$$\Delta P_{100} = .0172$$

$$W = .0764\, q'_h\, S_g$$

$$= .0764 \times 108034.8 \times 1.28$$

$$= 10564.94$$

$f = .0155$ ($\mu = .00$) (NOMOSCAPH)

$$\rho = \frac{2.7\, P' S_g}{T} = \frac{2.7\,(144.99 + 15)\,1.28}{530}$$

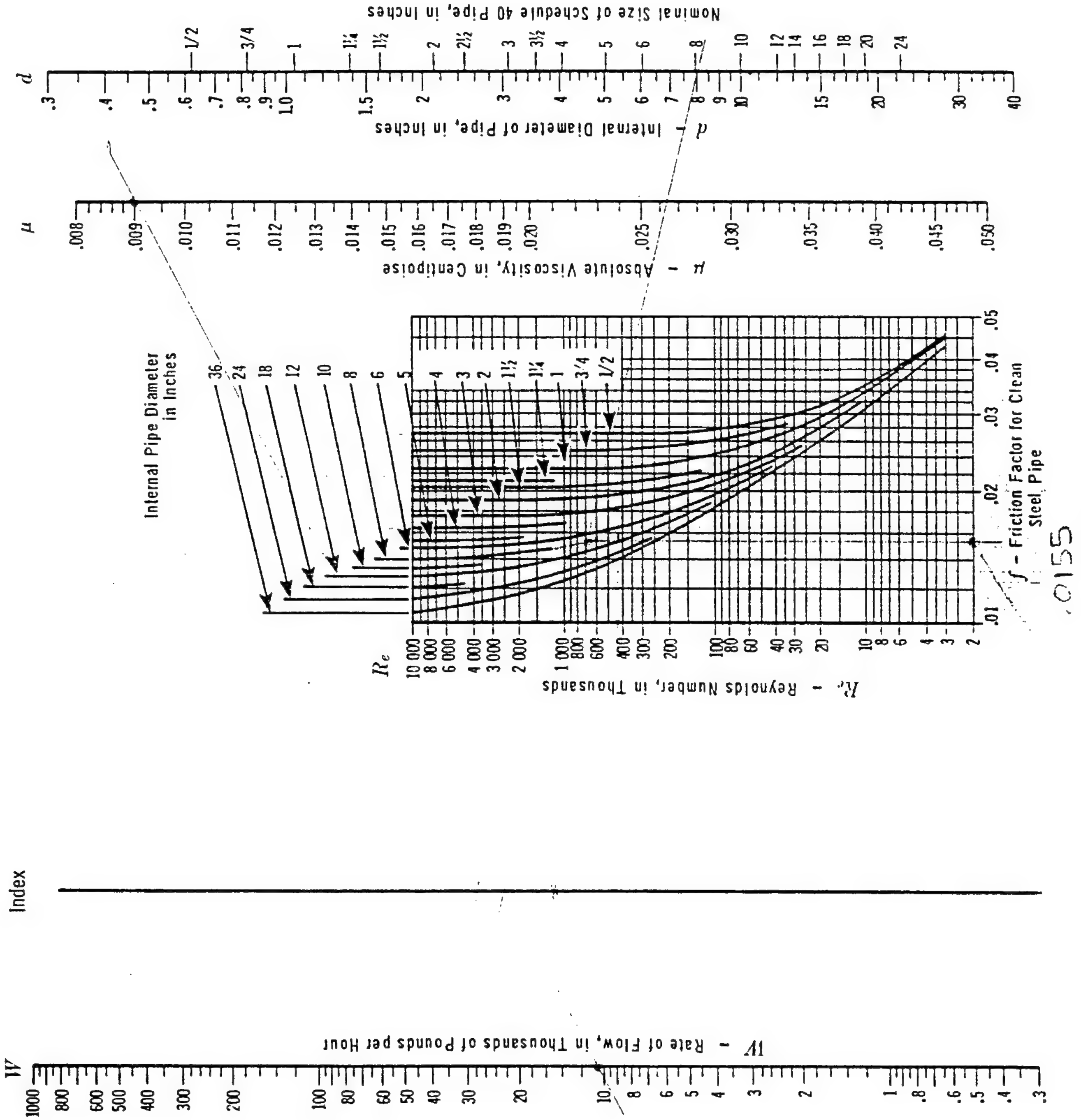
$$\rho = 1.043$$

$$\Delta P_{TOT} = \Delta P_{100} \times \frac{l}{100} = .0172 \times 44.6 = .767 \text{ PSIG}$$

Sheet 18 of 26
7469

Reynolds Number for Compressible Flow
Friction Factor for Clean Steel Pipe

ΔP CALC FOR BINT #11



SIMONS

CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

SUBJECT LPG Pipeline Pressure Drop SHEET NO. 19 OF 26 JOB NO. 7469

BY ______ DATE ______ CHKD. BY ______ DATE ______

ΔP TO POINT #12

$$\Delta P_{100} = .000336 \frac{f W^2}{d^5 \rho}$$

$$= .000336 \frac{.0155 \times 10449.64^2}{7.981^5 \times 1.038}$$

$$\Delta P_{100} = .0169$$

$$W = .0764\, q_h'\, S_g$$

$$= .0764 \times 106855.8 \times 1.28$$

$$= 10449.64$$

$f = .0155$ ($\mu = .002$) (NOMOGRAPH)

$$\rho = \frac{2.7 P' S_g}{T} = \frac{2.7 (144.22 + 15) 1.28}{460 + 70}$$

$$\rho = 1.038$$

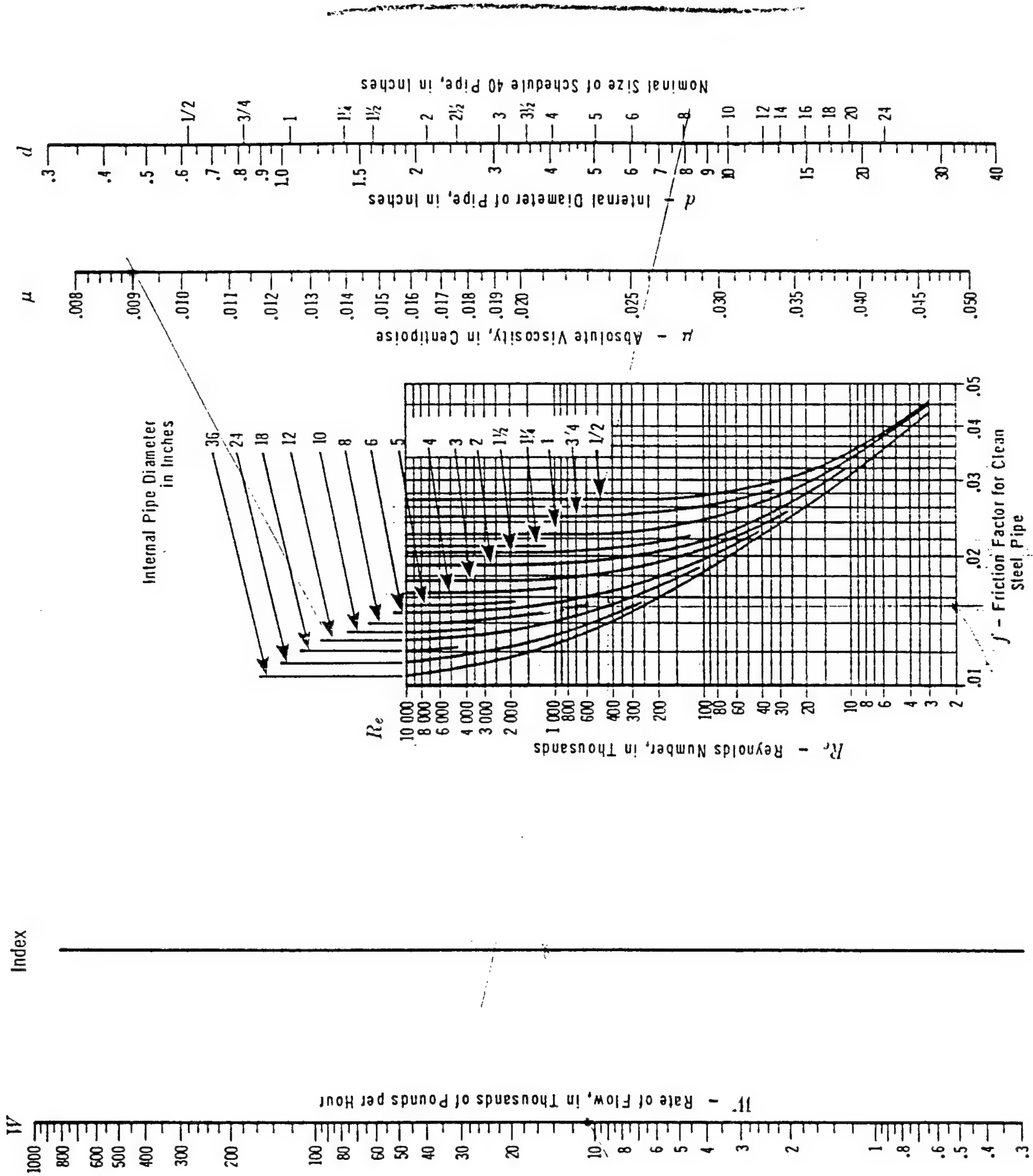
$$\Delta P_{TOT} = \Delta P_{100} \times \frac{L}{100} = .0169 \times 23 = .389 \text{ PSIG}$$

7469

Sheet 20 of 26

Reynolds Number for Compressible Flow
Friction Factor for Clean Steel Pipe

ΔP CALC FOR POINT #12



SIMONS

CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-320(

SUBJECT LPG Pipeline Pressure Drop SHEET NO. 21 OF 26 JOB NO. 746c

BY ______ DATE ______ CHKD. BY ______ DATE ______

ΔP TO POINT #13

$$\Delta P_{100} = .000336 \frac{f W^2}{d^5 \rho}$$

$$= .000336 \frac{.016 \times 8069.6^2}{7.981^5 \times 1.036}$$

$$\Delta P_{100} = .0104$$

$$W = .0764\, q_h'\, S_g$$

$$= .0764 \times 82518 \times 1.28$$

$$= 8069.6$$

$f = .016$ ($\epsilon = .009$)(NOMOGRAPH)

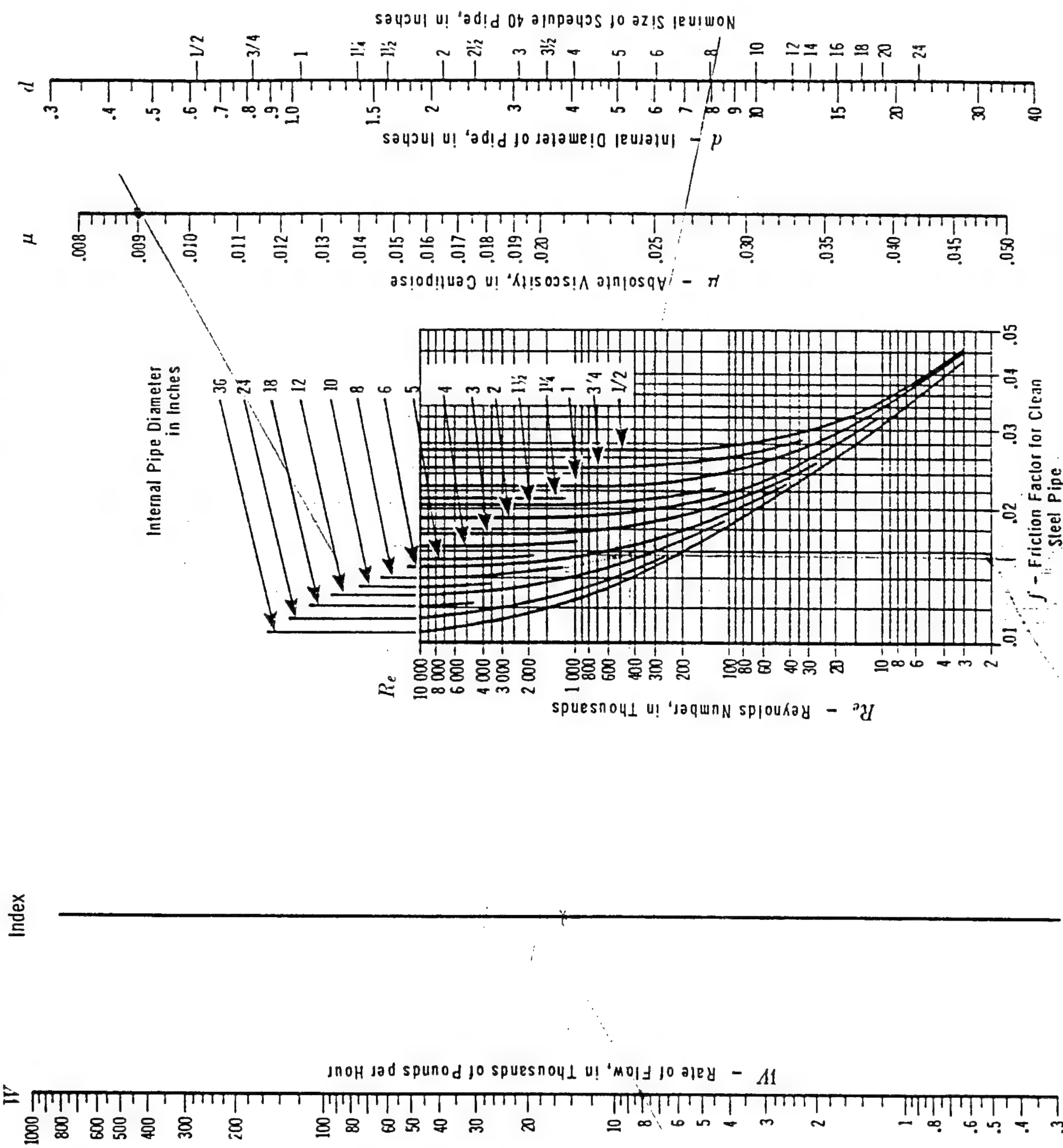
$$\rho = \frac{2.7\, P'\, S_g}{T} = \frac{2.7\,(143.83+15)\,1.28}{460+70}$$

$$\rho = 1.036$$

$$\Delta P_{TOT} = \Delta P_{100} \times \frac{l}{100} = .0104 \times 13.75 = .143 \text{ PSIG}$$

Reynolds Number for Compressible Flow
Friction Factor for Clean Steel Pipe

ΔP CALC FOR POINT #3



ΔP To Point #14

$$\Delta P_{100} = .000336 \frac{f W^2}{d^5 \rho}$$

$$= .000336 \frac{.016 \times 6862.06}{7.981^5 \times 1.035}$$

$$\Delta P_{100} = .0075$$

$$W = .0764\, q_h'\, Sg$$

$$= .0764 \times 70170 \times 1.28$$

$$= 6862.06$$

$f = .016$ ($\mu = .006$) (NOMOGRAM)

$$\rho = \frac{2.7\, P'\, Sg}{T} = \frac{2.7\,(143.69 + 15)\,1.28}{460 + 70}$$

$$\rho = 1.035$$

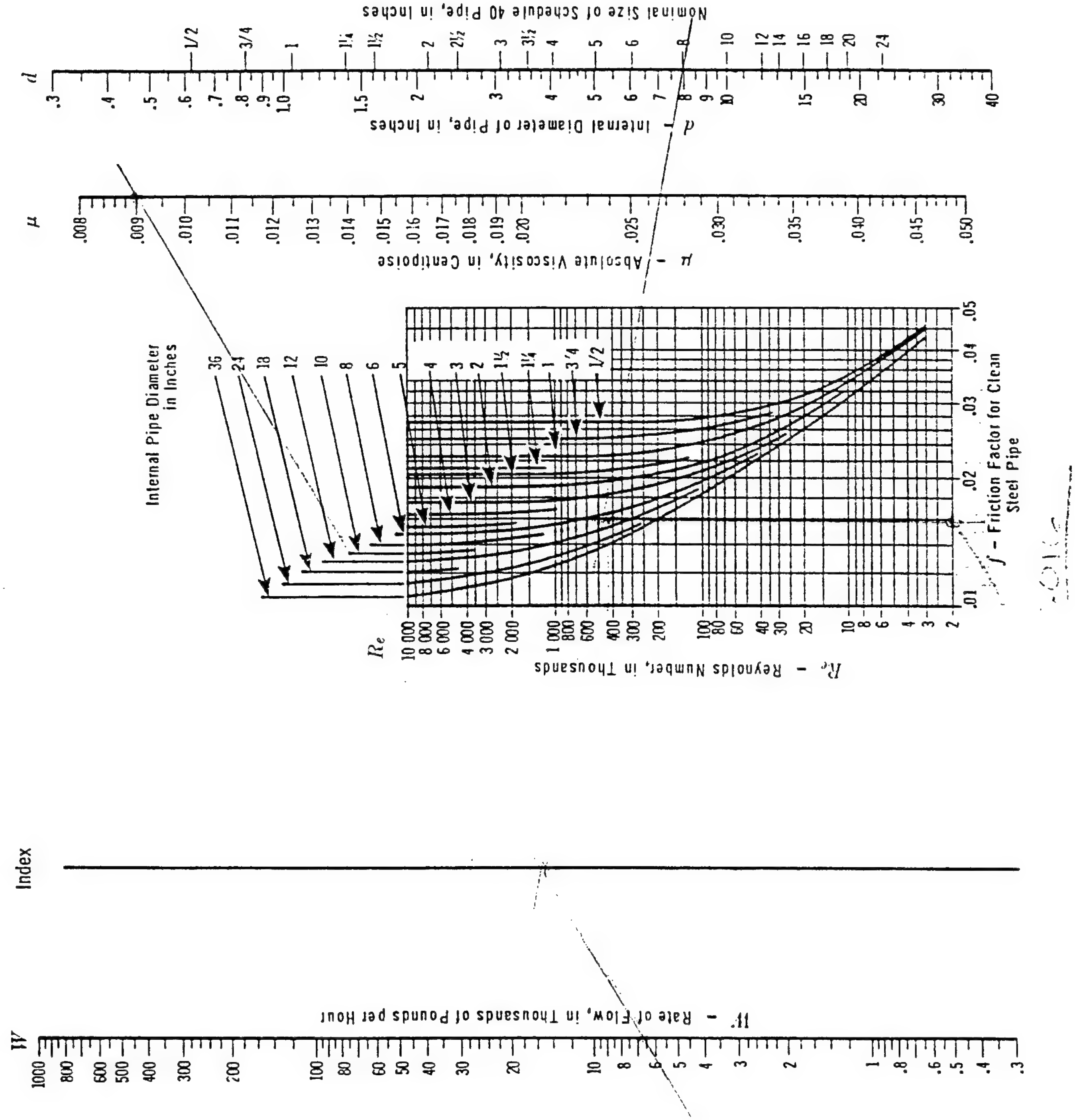
$$\Delta P_{TOTAL} = \Delta P_{100} \times \frac{l}{100} = .0075 \times 23 = .172 \text{ PSIG}$$

Sheet 24 of 26

7469

Reynolds Number for Compressible Flow
Friction Factor for Clean Steel Pipe

ΔP CALC FOR POINT #14



SIMONS # CALCULATION SHEET

SIMONS-EASTERN CONSULTANTS, INC. P.O. BOX 1286, ATLANTA, GEORGIA, U.S.A. 30301, 404-370-3200

ΔP TO POINT #15

$$\Delta P_{100} = .000336 \frac{f W^2}{d^5 \rho}$$

$$= .000336 \frac{.016 \times 5692.67^2}{7.981^5 \times 1.034}$$

$$\Delta P_{100} = .0052$$

$$W = .0764\, g_h'\, S_g$$

$$= .0764 \times 55212 \times 1.28$$

$$= 5692.67$$

$f = .016$ ($\mu = .007$) (Nomograph)

$$\rho = \frac{2.7\, P'\, S_g}{T} = \frac{2.7\,(143.52 + 15)\, 1.28}{460 + 70}$$

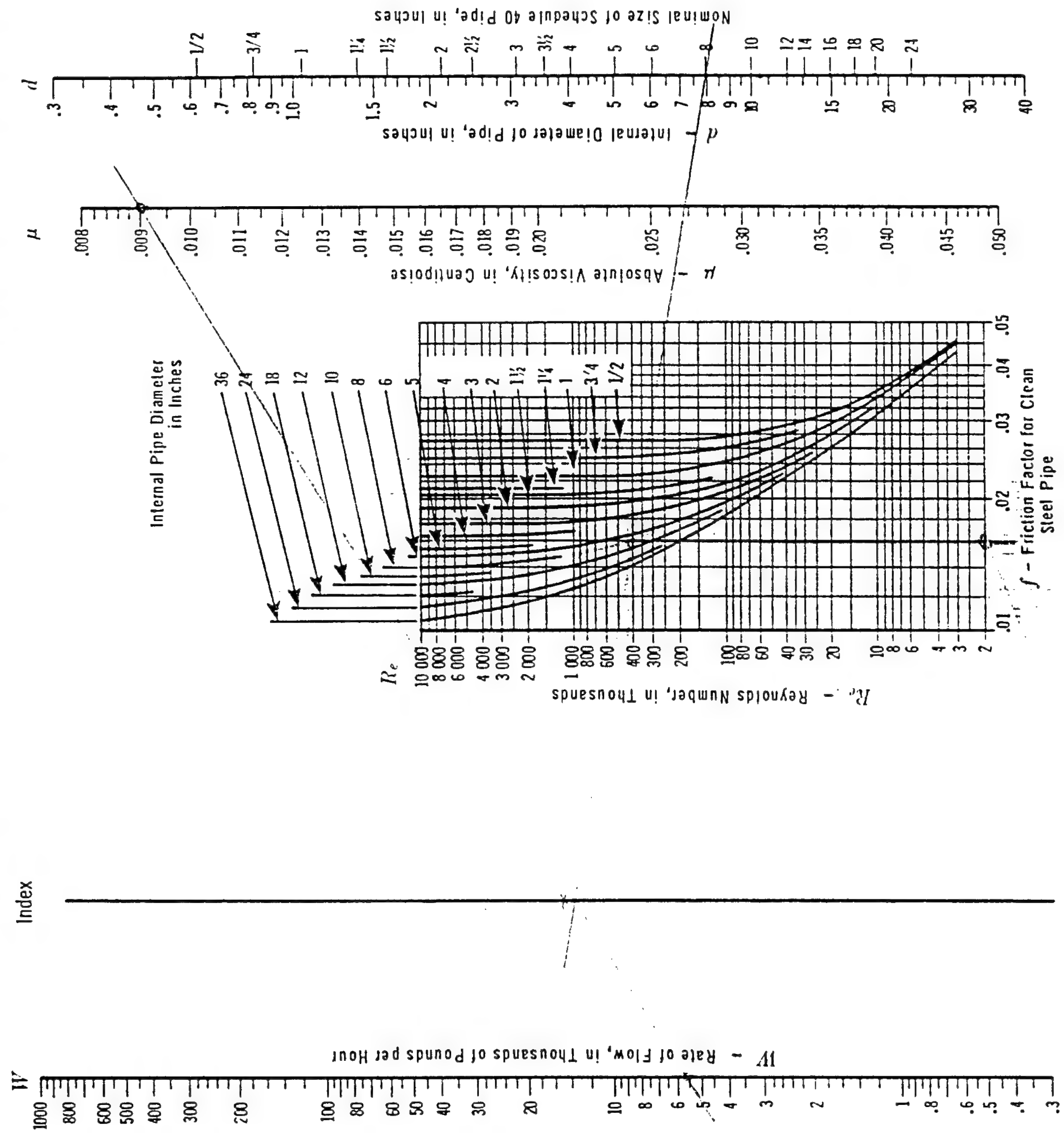
$$\rho = 1.034$$

$$\Delta P_{TOTAL} = \Delta P_{100} \times \frac{l}{100} = .0052 \times 9.70 = .05 \text{ PSIG}$$

Sheet 26 of 26
74.1 C

Reynolds Number for Compressible Flow
Friction Factor for Clean Steel Pipe

ΔP CALC FOR POINT #15



SIMONS

TRIP REPORT NO. 1

SIMONS-EASTERN CONSULTANTS, INC. ONE WEST COURT SQUARE, DECATUR, GA 30030 (404) 370-3200

DATE 08/13/92	WRITTEN BY J. M. Kistner	PAGE 1 of 2

PROJECT	Fort Gordon LPG System Study Fort Gordon, Georgia	PROJECT NO. 7469B FILE NO. 43 DATE OF TRIP 7/14-17/92
LOCATION OF TRIP	Fort Gordon, Georgia	
PURPOSE OF TRIP	Investigate Buildings and Pipeline Routing	
ATTENDEES	Simons-Eastern Bill Smith Allen Naylor Bill Ross Jim Kistner	

ITEM	DESCRIPTION	ACTION BY	REQUIRED DATE
1.	The trip started with an in-brief meeting attended by Mr. Ira Hefner representing the Savannah District, Mr. Curt Oglesby and Ms. Harriet Tanksley representing Ft. Gordon DIS.		
	S-E was furnished with a copy of the current DFSC natural gas contract and AR 415-15.		
	Curt Oglesby furnished a data gathering spreadsheet identifying the buildings DIS personnel would investigate as part of the study.		
	The overall plan for the field investigation was discussed and arrangements were made for escorts for investigating family housing units and other buildings where necessary.		
2.	Several housing units in McNair Terrace, Olive Terrace and Gordon Terrace were investigated. Data gathered included sizes of heating units, hot water heaters, and ranges. Notes were made on building construction, types and number of doors and windows.		
	It was noted and confirmed by Ft. Gordon personnel that all housing units had identical equipment.		
3.	The 18 buildings identified for S-E to investigate were inspected and the users of natural gas in each building were identified, and the size and fuel requirements recorded.		

ITEM	DESCRIPTION	ACTION BY	REQUIRED DATE

4. An additional 14 buildings were also inspected by S-E personnel to relieve DIS of the additional responsibility. DIS personnel investigated 12 buildings and furnished the natural gas use requirements for each.

5. Curt Oglesby furnished a listing of all buildings to be included in the study that included a cross reference to the buildings inspected to identify similar loads.

6. Real Estate records were obtained for all buildings inspected and for representative housing units. This provided one more source of data to verify and supplement information gathered during the building survey.

7. The entire 6 mile route for the proposed new gas pipeline was inspected. Conditions affecting the construction and cost of the line were noted.

   A revised routing along 9th Street was selected in lieu of 10th Street to avoid congestion and added cost.

8. A meeting was held with Mr. Carlton Shuford to discuss expansion plans for Fort Gordon. Details are contained in separate meeting minutes.

9. A meeting was held with representatives of Atlanta Gas Light Company to discuss the pipeline relocation and alternatives for the new service. Details are contained in separate meeting minutes.

10. The EMCS system was investigated. The system was made by Dorsett Electronic Control Systems and consisted of:

    - a host computer
    - field interface devices
    - multiplexing units
    - various sensors

    The multiplexing unit scans all the field sensors and transmits data to the field interface device. The field interface device sends the results back to the host computer in the control room. Manual optimization setpoint is accomplished in the host computer and transmitted to the field interface devices. If closed loop control is desired, it is

ITEM	DESCRIPTION	ACTION BY	REQUIRED DATE
	done in the field interface device. The present system is a digital transmitted system, but has the capability to receive analog signals. The present system has adequate room for expansion.		

J. M. Kistner

J. M. Kistner

JMK/kds

SIMONS

MEETING MINUTES NO. 1

SIMONS-EASTERN CONSULTANTS, INC. ONE WEST COURT SQUARE, DECATUR, GA 30030 (404) 370-3200

DATE 08/12/92	WRITTEN BY J. M. Kistner	PAGE 1 of 1
PROJECT Fort Gordon LPG System Study Fort Gordon, Georgia	PROJECT NO. 7469B FILE NO. 45 DATE OF MEETING 7/16/92	
LOCATION OF MEETING	Directorate of Installation Support, Bldg. 2130 Ft. Gordon, Georgia	
PURPOSE OF MEETING	Review Potential Expansion at Fort Gordon	
ATTENDEES	Mr. Carlton Shuford - DIC Mr. Curt Oglesby - DIS	Bill Smith - Simons-Eastern Jim Kistner - Simons-Eastern

ITEM	*DESCRIPTION*	*ACTION BY*	*REQUIRED DATE*
1.	The attached Point Paper, dated 19 June 1992, was presented by Mr. Shuford.		
2.	There will be no net gain in building square footage over the next 10 years. For every square foot of new building, an equal amount of old WWII buildings must be demolished. Also, there is a quota for demo of WWII buildings.		
3.	There is a possibility of a MI Brigade moving to Fort Gordon. Approx. 800 additional personnel will be absorbed into existing housing.		
4.	There is an outside chance that additional family housing would be constructed near Gordon Terrace. This is not currently needed.		
5.	Information needed for the 1391 Processor includes: • Description of the project, include components, function, demolition • Any asbestos in demolition • Current situation, requirements, needs • Impact, if not provided • Provide each block of text in Wordperfect ASCII file		

J. M. Kistner

J. M. Kistner

JMK/kds

POINT PAPER

SUBJECT: Fort Gordon Military Construction, Army (MCA) Program

ISSUE: Provide Update on Fort Gordon's MCA Program

BACKGROUND: Fort Gordon has had an active MCA Program over the years. A total of $61,779,213 was spent on major projects between FY 85 and FY 90. There are $40,256,290 in projects programmed for FY 91 through FY 95.

CURRENT STATUS (AS OF 12 JUN 92): LISTED BELOW ARE THE DESCRIPTION AND STATUS OF PROJECTS PROGRAMMED FOR FY 90 THROUGH FY 95.

-- FY 90:

-- SATCOM II. Current Working Estimate: $3,511,791. This 38,000 square foot project constructs the second of two increments of a Satellite Communications Applied Instruction Complex. STATUS: Construction is underway. Estimated completion is 13 SEP 92.

-- FY 91:

-- Soldier Service Center. Current Working Estimate: $7,250,000. Construct a 107,000-square foot Soldier Service Center to centralize all in-/out-processing activities. This project is essential to provide a compact, modern, and efficient facility for the nine agencies involved with in/out-processing of 74,000 people each year. Consolidation of facilities will improve operational efficiency and morale, increase productivity, and reduce energy consumption and maintenance costs. Flexibility of the new facility will allow for mission change or growth in an orderly manner. This center is the first and last point of contact for personnel and families with Fort Gordon. A functional, modern facility manned by an efficient staff creates positive impressions to those being processed. STATUS: Construction began 15 NOV 91. Occupancy date 04 NOV 93.

-- 600-Man U.S. Army Reserve Center (U.S. Army Reserve Project). Current Working Estimate: $8,730,545. This 79,200-square foot project will provide adequate training facilities for all assigned reserve units, allowing them to train as an entity, to develop teamwork and enhance unit readiness. The new facility will relieve current overcrowding and will be more economical to maintain than the current facility located in Augusta. STATUS: Authorization to advertise for bids was issued 14 MAY 92.

-- Family Practice Clinic (Health Services Command (HSC) Project). Current Working Estimate: $3,181 745. This 32,400 square-foot project is required to house the Department of Family Practice (DFP) and the Family Practice Clinic (FPC). These functions are currently housed in an area intended for in-patient care. Personnel migrating to Fort Gordon under the Health Services Command's (HSC) Base Realignment and Closure (BRAC) initiative will require Eisenhower Army Medical Center (EAMC) to open two additional in-patient wards to support the resulting increase in Graduate Medical Education Programs and the support tail. STATUS: Construction began 08 OCT 91 and occupancy is expected 23 FEB 93.

-- FY 92. Expand Energy Monitoring and Control System (EMCS). Current Working Estimate: $1,119,000. This project replaces the central control system, upgrades existing Field Interface Devices (FIDs), and constructs an extension of the existing EMCS to monitor and control energy consumption for miscellaneous buildings and structures. This project is required to reach Army energy goals and to comply with the Federal Energy Management Improvement Act of 1988 and the National Energy Policy Act to reduce energy usage. It is submitted as part of the Energy Conservation Investment Program (ECIP). A central EMCS is an effective means of automatically reducing energy consumption during the heating and cooling season. STATUS: Design is complete and the authority to advertise was received 20 Feb 92. Procurement authority for the computerized systems has been received and bid advertisement dates are expected within the next 30 days.

-- FY 93. No projects are scheduled for FY 93. Several projects have been identified as potential projects for expedited execution in this fiscal year.

Whole Barracks Renewal (Phase 1)

Table of Organization and Equipment Motor Pool (Phases I and II)

-- FY 94. Clinical Investigation Lab (HSC Project). Current Working Estimate: $4,500,000. This 25,000-square foot project is required to provide adequate facilities to accomplish the stated mission of the Department of Clinical Investigation. Biomedical research requires that laboratory and animal facilities be collocated to meet the mission needs. The animal facility areas provide for breeding, holding, quarantine, exercise, and care of research animals. The Clinical Investigation Program has been designated an essential component of medical care and teaching by the Department of Defense. STATUS: The 35% design submittal is under review. Although officially listed as an FY 95 project, the current project schedule(12 MAR 92) calls for Construction Contract Award in October, 1993, indicating possible funding with FY 94 funds.

-- FY 95. Consolidated Field Maintenance Facility. Current Project Estimate: $22,000,000. This project will provide 184,000 s.f. of modern maintenance facility space to replace World War II era wood facilities. The new facility will provide a central facility for the consolidation of DS/GS maintenance activities, including electronic repairs, vehicle repair and overhaul, weapons repair, and other support maintenance. Many of these functions require specialized equipment and environmental conditions which cannot reasonably be met or maintained at under the current facility conditions. STATUS: Project has been approved for selection of an Architectural- Engineering firm.

--FY 96 and Beyond: The following is a list of our long range planning requirements reflecting the remaining top 9 MCA priorities and the current active program for Army Family Housing (AFH). Projects that are indicated by * have been identified as potential projects for acceleration.

FY 97

* (1) Renovate Barracks (Phase 1). One of two projects to renovate and upgrade barracks, occupied by permanent party, unaccompanied enlisted personnel.

(could be FY 96 or 97)

(2) Table of Organization and Equipment (TOE) Motor Pool Facility (Phase I & 2). Construct permanent facility to meet motor pool requirements for the 67th Signal Battalion and the 63rd Signal Battalion. This project will replace the current TOE motor pool complex on Chamberlain Avenue.

* (3) Renovate Barracks (Phase II). Second project to renovate and upgrade barracks complex. This project will complete the phased renovation of 25 year old barracks occupied by permanent party personnel.

(4) Emergency Services Complex. Construct an 11,000 s.f. facility to centralize the Fire Prevention and Protection Division, Safety Office, and EMS Service. This centralization will provide better efficiency in the utilization of emergency response activities, vehicles, and manpower.

FY 97

(5) Dining Facilities Modernization. Renovate three dining facilities in the Signal School billeting area along Chamberlain Avenue. This project will upgrade and modernize the existing dining and food preparation areas to meet current standards.

(6) Widen Entrance Roads (Gates 1 and 5). Widen Chamberlain Avenue at Gate 1 and Avenue of the States at Gate 5 to four lanes. New highway construction projects for roads outside these gates require Fort Gordon to improve the safety and circulation of the existing installation access roads.

FY96 (7) Modernize/Consolidate Ranges. Consolidate 14 existing ranges into a five-range complex, centered on the existing Range Control Building. Included in the TRADOC FY 95 Program, this project has been moved back to a later program year to allow further development of documentation.

(8) Training Aids Facility. Construct a 78,000-square foot facility to combine the Training Service Center's functions into a single, efficient production facility. It will incorporate the device production, photo/graphic arts, storage, supply, and administration areas.

(9) Physical Fitness Center. Construct a 24,600-square foot facility to include a multipurpose court, nautilus room, aerobics/exercise room, and racquetball courts. The proposed site is adjacent to the indoor swimming pool and outdoor running track, creating a total fitness complex. The facility will be centrally located near the Signal School's academic area and will serve as a physical training center for the students.

FY96 ARMY FAMILY HOUSING (AFH) A Whole Neighborhood Revitalization. A project for the total revitalization of neighborhood areas, this project is being formulated for the FY 96 Program by combining two previously programmed projects to create a unified "neighborhood" approach to housing development. The result will be a total community renewal including utility, architectural, structural, site and recreational elements.

RECOMMENDATION: None - Information.

CARLTON L. SHUFORD, DSN 780-6534
ATZH-DIC-E
19 June 1992

MEETING MINUTES NO. 2

SIMONS

SIMONS-EASTERN CONSULTANTS, INC. ONE WEST COURT SQUARE, DECATUR, GA 30030 (404) 370-3200

DATE 08/12/92	WRITTEN BY J. M. Kistner	

PROJECT	Fort Gordon LPG System Study Fort Gordon, Georgia	PROJECT NO. 7469B FILE NO. 45 DATE OF MEETING 7/16/92
LOCATION OF MEETING	Directorate of Installation Support, Bldg. 2130 Fort Gordon, Georgia	
PURPOSE OF MEETING	Discuss New Pipeline Routing, Review Gas Records	

ATTENDEES

Ga. Natural Gas (Div. of Atlanta Gas Light Co.)
Ian Skelton
Andy Harrison
Denny Works

Simons-Eastern
Bill Ross
Jim Kistner

DIS
Curt Oglesby

ITEM	DESCRIPTION	ACTION BY	REQUIRED DATE

1. Atlanta Gas Light records on gas consumption for the period of January, 1988 thru June, 1992 were furnished.

2. Recent times of gas curtailment to Fort Gordon were furnished:

   12/16/89 - 8 a.m. to 12/17/89 - 11 a.m.
   12/21/89 - 4 p.m. to 12/26/89 - 8 p.m.
   01/16/92 - 3 p.m. to 01/17/92 - 10 a.m.

   These are the only periods of curtailment between December, 1989 and present. For gas use purposes, AGL considers 8 a.m. to 8 a.m. as one day. During the period of 12/21/89 to 12/26/89, there were 4 full days of curtailment to Fort Gordon. These records provide a good representation of what the fort can reduce gas consumption to during curtailment.

3. The existing pipeline, when installed, was coated and wrapped pipe. The line is cathodically protected, but there is no rectifier on the fort. If the existing line is isolated from the new line, a rectifier should be installed on the existing pipe.

4. The existing pipe is in good condition and does not have a history of leaks or deterioration.

5. The potential routing of the new line was discussed. The routing is generally acceptable but AGL insisted that they must be responsible for installation if they are to be the eventual owner. It was explained that this may not be possible due to government procurement regulations, but the line could be specified to be built to conform to AGL specs.

6. Atlanta Gas Light would be agreeable to a property trade of the existing line for the new line. AGL may also consider keeping the existing line as well and maintaining the distribution system for Fort Gordon.

7. Denny Works offered to share current pipeline construction cost data with S-E. We will contact his office next week for information.

8. Atlanta Gas Light offered that it would be more advantageous to them, and probably to Fort Gordon as well, to locate the new gas main outside the fort, to the east. This would give them an opportunity to increase their customer base in the area of the National Science Center and other development that is occurring in the vicinity of Gate 1.

9. Atlanta Gas Light was questioned regarding the potential impact the reduction in firm gas might have on the operation of their system, and the rates to their customers. They responded that their operation would not be affected and that their customer base was large enough that rates would not be affected by the firm gas reduction.

10. AGL also stated that because of industry deregulation, they did not intend to keep any more firm gas than was necessary. In the future, all space in the pipeline supplying natural gas to AGL will be available on a "for bid" basis.

11. AGL stated that the existing metering station near Gate 3 should remain as the delivery meter to Fort Gordon after the new pipeline is installed. These are the newest and most accurate meters. It also would be costly to move the meters to another location, not only because of construction cost, but also because of telemetering connections to the telephone lines.

J. M. Kistner

J. M. Kistner

JMK/kds

cc:

SIMONS

RECORD OF DISCUSSION

SIMONS-EASTERN CONSULTANTS, INC. ONE WEST COURT SQUARE, DECATUR, GA 30030 (404) 370-3200

PROJECT	Fort Gordon LPG System Study Fort Gordon, Georgia		
PROJECT NO.	7469B	FILE NO.	18
DATE OF DISCUSSION	7/28/92	TIME	
SUBJECT	Ft. Gordon Gas Line Relocation		

In person at ______ By phone at ______

By long distance from Decatur, Georgia

to Augusta, Georgia between Jim Kistner

of Simons-Eastern Consultants, Inc. and Carl Pearson

of Georgia Natural Gas Company Phone Number 706-738-9860

1. Carl Pearson is an engineer that works with Denny Works.

2. Estimated costs that Georgia Natural uses for budgeting projects are: installed costs and material for 8" line = $21.29/l.f.

3. Carl will send maps that show location of 8" main to Fort Gordon. The tap station off the southern natural pipeline is 3 miles east of Ft. Gordon on Tobacco Road near Windsor Road. Widening of Tobacco Road from Windsor Road to Gate 5 is scheduled to begin in 1994 which will require relocation of the pipeline along Tobacco Road. This may be an appropriate time to make adjustments that would coordinate with the pipeline relocation across Ft. Gordon.

4. An alternate way to service Fort Gordon could be by a new supply line to Gate 3. Georgia Natural recently installed a new 12" gas main from Wrens, Georgia, thru Harlem, north of Grovetown, across I-20 to Washington Road near Evans and Martinez. It may be possible to service Grovetown and possibly Fort Gordon from this line rather than relocating the new line through or around the Fort.

Jim Kistner

Jim Kistner

JK/kds

RECORD OF DISCUSSION

SIMONS

SIMONS-EASTERN CONSULTANTS, INC. ONE WEST COURT SQUARE, DECATUR, GA 30030 (404) 370-3200

PROJECT Fort Gordon LPG System Study Fort Gordon, Georgia	
PROJECT NO. 7469B	FILE NO. 18
DATE OF DISCUSSION 8/7/92	TIME
SUBJECT Ft. Gordon Gas Line Relocation	

In person at ______ By phone at ______

By long distance from Augusta, Georgia

to Decatur, Georgia between Jim Kistner

of Simons-Eastern Consultants, Inc. and Carl Pearson

of Georgia Natural Gas Company Phone Number 706-738-9860

Georgia Natural/Atlanta Gas Light could furnish and install the necessary control fittings and bypass connections required to make the tie-ins to the existing line while maintaining service in the line. The estimated cost would be $30,000 for each tie-in. This price does not include permanent valves or other fittings required on the new line.

Jim Kistner

Jim Kistner

JK/kds

SIMONS

RECORD OF DISCUSSION

SIMONS-EASTERN CONSULTANTS, INC. ONE WEST COURT SQUARE, DECATUR, GA 30030 (404) 370-3200

PROJECT Fort Gordon LPG System Study Fort Gordon, Georgia	
PROJECT NO. 7469B	FILE NO. 18
DATE OF DISCUSSION 8/3/92	TIME
SUBJECT Peak Shaving System	

In person at ______ By phone at ______

By long distance from Decatur, Georgia

to LaGrange, Georgia between Bill Smith

of Simons-Eastern Consultants, Inc. and Danny Tilson

of City of LaGrange Phone Number 706-883-2000

- System for peak shaving with 60% natural gas.
- Sized at 120,000 cfh at 25 psig.
- Propane fired water bath vaporizer
- Southern National Gas system has 20 psig header
- 17 - 30,000 gallon tank.
- A 50/50 mix of propane air with natural gas is no problem except for yellow flame.
- Has deal with propane supplier, pays for only driver in summer. Supplier tries to sell as much propane as possible in summer to have access to winter gas.
- Mixer is specific gravity controlled to 1.12.
- Used 70% propane air to 30% natural gas in December, 1989. Most complaints due to space heaters needing readjustments.
- Takes 1 hour for cold start-up of system.
- Propane air plants are safe!

Bill Smith

Bill Smith

BS/kds

SIMONS

RECORD OF DISCUSSION

SIMONS-EASTERN CONSULTANTS, INC. ONE WEST COURT SQUARE, DECATUR, GA 30030 (404) 370-3200

PROJECT Fort Gordon LPG System Study Fort Gordon, Georgia	
PROJECT NO. 7469B	FILE NO. 18
DATE OF DISCUSSION 7/31/92	TIME
SUBJECT Ft. Benning Peak Shaving System	

In person at ______ By phone at ______

By long distance from Decatur, Georgia

to Ft. Benning, Georgia between Bill Smith

of Simons-Eastern Consultants, Inc. and Glenn Todd, Utility Sales Officer

of Ft. Benning, Georgia Phone Number 706-545-1034

- Peak shaving system installed in 1950.
- Propane/air mix is 60%/40%. Spec. gravity meter controls mix to 1025 BTU per cu. ft.
- Mixes with natural gas at 25% propane-air with 75% natural gas.
- System sized to meet firm gas commitments of 37,000 ccf/day firm (based on summer load)
- Use oil back-up for large boilers.
- Changeover is done gradually by throttling natural gas and injecting propane air mix at 30 psi.
- Vaporizer is steam heated by package steam generator at 15 psi. Generator is natural gas fired.
- Mixer is series of valves with compressed air.
- Header pressure is 30 psig, house pressure is 7" w.c.
- System start-up takes 45 minutes from cold start.
- Slight compatibility problem with high propane-air mixture, some pilot lights blow out.
- Ft. Benning has reduced firm gas commitment by ½ in 15 years.

- City of LaGrange has peak shaving system that has been used for 100% propane-air.

Bill Smith

BS/kds

Vendors	No. of Sheets
Energistics, Inc. Birmingham, Alabama	6
Alternate Energy Systems, Inc. Peachtree City, Georgia	17
Plant Systems, Inc. Cleveland, Ohio	16
Insertion Mass Flowmeter	2

ENERGISTICS, INC.®

2921 - 2ND AVE. SO.
BIRMINGHAM, ALABAMA 35233
PHONE (205) 324-5785

August 6, 1992

Simons Eastern Corporation
1 West Court South
Decatur, GA 30030

Attention: Mr. Bill Smith

Re: Propane-Air System for Army Base, Our letter dated July 29, 1992.

Dear Bill:

In response to our recent telephone conversation, we will offer these different budget prices for systems at a different pressure. Our letter of July 29, 1992, indicated a Propane-Air System with six (6) 30,000 gal. storage tanks and a vaporizer-mixer air compressor system that would make 150 PSIG.

You now want an alternate on a 230,000,000 BTU/hr system at 75 PSIG and an 84,000,000 BTU/hr system at 75 PSIG.

As indicated in our telephone conversation, your alternate #1 for 230,000,000 BTU/hr at 75 PSIG would be $825,000.00.

If you go with alternate #2 for 84,000,000 BTU/hr at 75 PSIG with the same six (6) 30,000 gal propane storage tanks, the price would be $700,000.00

Again, for each additional 30,000 gal tank installed please add $60,000.00 in groups of sixes.

VAPOR/MIXER/AC	$325,000
TANKS (6)	375,000
	700,000

Very truly yours,

Energistics, Inc.

Boyce Guthrie

BG:ms

ENERGISTICS, INC.®

2921 - 2ND AVE. SO.
BIRMINGHAM, ALABAMA 35233
PHONE (205) 324-5785

July 29,1992

Simmons Eastern Corporation
1 West Court South
Decatur, GA 30030

ATTN: Mr. Bill Smith

SUBJECT: Propane Air System For Army Base

Dear Bill:

As promised during our recent telephone conversation we are enclosing some rough specifications and drawings on a propane air system similar to the one we discussed.

You had also asked for a budget figure for the installation of a system that would have the capability of producing 230 million BTU/hr of propane air mix at a pressure of 150 PSIG. You also asked that we break down the prices of the system installed by tanks, vaporizer mixer, compressor, and etc.

We would recommend the vaporizer mixer to have the maximum capability and the storage tanks to be sized to provide 100 million BTU/hr for five (5) or six (6) days. At this rate you would consume 26,373 gal/day. Therefore, we are recommending six (6) 30,000 gallon propane storage tanks.

The system would be priced install as follows:

PER GROUP OF 6 TANKS

Six (6) propane storage tanks with the appropriate fittings, trim, piping, fencing, and etc. **$375,000.00**

Vaporizer mixer and appurtenances with controls installed **$300,000.00**

Air compressors with controls, building and etc. **$275,000.00**

$450 K FOR 75 PSIG SYSTEM

This would give a total install price of **$950,000.00.**

For each additional 30,000 gallon tank installed, please add **$60,000.00.**

Bear in mind that once very specific information is available, these prices could change.

The next time I am in the Atlanta area, I will call and maybe we can get together and discuss these systems in more detail.

Very truly yours,

8/4/92 DEDUCT $125,000 FOR 75 PSIG SYSTEM

Energistics, Inc.

Boyce Guthrie TS

Boyce Guthrie, P.E.
BG/ts

LPG SOURCE AND DEFINITION

HYDROCARBONS cover a large class of chemical compounds containing carbon (C) and hydrogen (H) atoms. Hydrocarbons can be further broken down into subclassifications such as alkanes. Two principal alkanes are of concern: propane (C3H8) and butane (C4H10). Their molecular structures appear in Figure 1, along with that of methane (CH4). Propane and butane constitute the two most common types of LPG. In nature LPG occurs both as a co-product of natural gas and as a by-product of petroleum distillation, or fractionation processes. Current geological and geochemical data strongly suggest natural gas and petroleum represent products of low-temperature anaerobic decay of organic matter. The mobility of oil and gas from place of origin, however, usually masks any fossil or structural features that might provide definitive genetic evidence.

GENERAL INTRODUCTION

Liquefied petroleum gas, like water, exists in various phases depending on environmental conditions. Possible phases include liquid, vapor, and infrequently, solid. The discussion below uses water as an analogy. Two primary conditions, or parameters, determine what phase water exists in: pressure and temperature. A graphic depiction of water's stability fields appears in Figure 2. We call this type drawing a *phase diagram.* At sea level atmospheric pressure is 14.7 PSIA [1KG/CM2], and water boils at a temperature of 212 F [100 C]. During boiling, two phases, water and steam, coexist until all the water is converted to steam through the boiling process. This is a constant pressure, or *isobaric condition*. If we apply additional pressure, for example, by using a pressure cooker, we elevate the boiling point. At 20 PSIA we find that water boils at a temperature of 228 F [109 C]. People often use pressure cookers to shorten cooking time by boiling food at higher temperatures than can be attained under atmospheric conditions.

The above example is relevant when attempting to understand the properties of LPG. In the laboratory, scientists subject LPG (and other substances) to various temperature and pressure regiems and observe the resultant phase(s). They then plot the data points and create a phase diagram illustrating what phases exist under what specific pressure and temperature conditions. Figure 3 is the generalized phase diagram for propane. It appears similar to the one for water. The area occurring within the dashed boundary is of special concern to us because it covers the pressure and temperature range most commonly encountered in normal LPG

A VAPORIZER WHAT IS IT?

A vaporizer adds sufficient heat to liquid LPG to induce boiling and create a vapor phase. Figure 9 displays a basic vaporizer. In essence it is a "*heat exchanger*." Two basic types of vaporizer exist: *indirect fired* and *direct fired*. (See Figure 10). Direct fired vaporizers apply heat from a gas burner directly to a pressure vessel containing liquid LPG. Direct fired vaporizers, as appear in Figure 11, represent dated technology and violate many modern safety codes. Use of this type vaporizer is becoming increasingly rare. SDI does not manufacture a direct fired vaporizer. Indirect fired vaporizers transfer heat to the liquid LPG indirectly through a heat transfer medium. Common heat transfer mediums include water, steam, or electricity. SDI manufactures all three of these configurations. A conceptual example of this type vaporizer appears in Figure 12.

SIZING A VAPORIZER

Selecting the correct size and type of vaporizer for an application is critical. The list below contains important questions related to sizing a vaporizer.

QUESTION 1

What is the capacity requirement of the system?

The capacity requirement is the sum total of all the *hourly* heat input requirements of all the connected combustion equipment. Collect the heat input data directly from the burner dataplates! If the dataplate is missing, call the burner manufacturer and obtain the data. *Do not use an average daily value!* Provide the capacity requirement in BTU/HR, KCAL/HR, GPH or KG/HR. SDI recommends oversizing the vaporizer by ten to fifteen percent of the calculated load.

QUESTION 2

What type of LPG is to be vaporized: propane, butane or a mixture of propane and butane?

Thermodynamic characteristics of LPG family members vary significantly. For example, butane requires more energy to vaporize than does propane due to its higher boiling point and its higher latent heat of vaporization. To better understand this fact, refer to Appendix 4 and 5 and compare the boiling points of propane and butane at 100 PSIG [7.0 KG/CM2]. Note that for propane the boiling point is 65 F[18.3 C] while for butane it is 155 F [68.5 C]. A very substantial difference!

LPG/AIR MIXING

Why Mix LPG With Air?

Using an LPG/Air mixture is often more desirable than using undiluted LPG. Reasons include:

1. LPG/AIR mixtures possess combustion characteristics similar to natural gas. Burner, regulator, and orifice adjustments are generally unnecessary.
2. Dew point depression in LPG/Air mixes eliminate recondensation problems commonly associated with undiluted LPG vapor.

LPG/Air mixing systems provide a consistent, high quality combustible fuel with burning characteristics similar to natural gas. This interchangeability is attractive from a fuel marketing standpoint. LPG/Air plants allow a utility to "build up" a customer base during construction of a natural gas transmission line. The LPG/Air gas allows customers to install and use equipment designed for natural gas, before the arrival of the natural gas. LPG/Air systems also allow significant savings for *peakload* situations. For example, daily or hourly demand for natural gas can vary between ten percent to three hundred and fifty percent of the yearly average. Consequently, even though natural gas processing plants and transmission lines are sized for a very large capacity, only a small percentage of that capacity is typically used. An LPG/Air mixing system can provide for peak loads, rather than require installation of an additional expensive natural gas storage facility.

Finally, and most importantly, LPG/Air systems guarantee uninterrupted fuel distribution in emergency situations. It is far less expensive to install an LPG/Air mixing system than to back up one transmission pipeline with a second pipe line! In the United States and other parts of the world, emergency or *standby systems* are installed by individual customers as well as utility companies. Standby system benefit is threefold:

1. The client can obtain discounted *interruptible rates* from the natural gas suppliers. The client signs a contract with the natural gas supplier stating they can be restricted from obtaining natural gas during periods of high demand. The client's gas requirement during this period is met by the standby system.

2. The client assures himself of an uninterrupted fuel supply even during an emergency.

3. The client can burn the most economical fuel, whether it is natural gas or an LPG/Air mixture.

4. Oil as an alternate fuel is often not feasible due to environmental legislation, such as in much of Southern California (USA). Precautions required by law to to safeguard against leaky underground oil storage tanks also makes permitting and installation both difficult and expensive. The use of oil will also require special burners and significant adjustments to switch from natural gas to oil.

The advantages of LPG/Air as a standby fuel to natural gas are obvious. Below we examine the similarity of LPG/Air burning characteristics to those of natural gas, and the hydrocarbon dew point consequences of LPG/Air mixtures.

COMBUSTION PARAMETERS

Combustion parameters affecting fuel interchangeability include:

1: Specific Gravity
2: Calorific Value
3: Wobbe Index
4: Flame propagation and color

1. SPECIFIC GRAVITY

The specific gravity of a gas is its density relative to air. The specific gravity of air equals 1.0; natural gas is typically 0.60. Undiluted propane and butane vapor have specific gravities of 1.5 and 2.0, respectively. Consequently all propane/air or butane/air mixtures have a specific gravity greater than 1.0. Table 1 displays the heat value in BTU/FT3 [KCAL/NM3] and the specific gravity of various propane/air mixtures.

ALTERNATE ENERGY SYSTEMS, INC.
P.O. BOX 2469 PEACHTREE CITY, GEORGIA 30269
TELEPHONE (404) 487-8596
FAX (404) 631-4306

INTRODUCTION

Alternate Energy Systems, Inc, a corporation devoted to the solution of energy-oriented needs, represents the culmination of years of experience, knowledge, skill and proven results.

We're a company operated by experts. People with vast knowledge of the industry. People who are aware of energy problems - and know how to solve them.

Every member of AES has been closely involved with the energy needs in the past and continue to offer a more valid and precise solution to the energy needs of the present and future.

With total capability to handle you needs from start to finish, we are continuously aware that what we're doing is vital to the continued success and operation of those who use our equipment. For every dollar invested with an Alternate Energy System, we see to it that maximum return is realized quickly and efficiently.

WHAT IS A PROPANE STANDBY PLANT?

A "standby plant" - as the term implies, is something standing by to do a job. A propane standby plant, offered to industrial and utility users of natural gas, is a system that is an alternate source of energy in the event the natural gas source is curtailed or shutoff.

While some facilities use oil as a standby plant, oil is not a direct replacement for natural gas and will not burn in natural gas burners or applications. Thus, oil requires a separate set of burners, controls and piping.

Propane or LPG is an ideal standby fuel for natural gas because, propane when mixed with air, will duplicate the burning characteristics of natural gas and allows the user to utilize existing natural gas burners, piping and controls.

A propane system generally consists of:
- PROPANE STORAGE TANK(s)
- A VAPORIZER to convert the liquid propane to a gas
- A MIXER or BLENDER to mix the vaporized propane with air

WHY USE A STANDBY SYSTEM?

While there are many reasons a standby system is used, the principal reason is insurance against interruption of normal natural gas supplies. Another incentive is that many utility firms offer what is known as an "interruptable rate" industrial customers.

First - interruption of natural gas? Many are not aware that natural gas utilities purchase or contract from a pipeline, a certain amount of natural gas for a certain period.This supplies both residential users as well as industrial users. However, the residential user is the priority user and, during an unusually long winter or unexpected cold spells, the residential user will consume more natural gas than anticipated - leaving less for the industrial user.

For the industrial user, not receiving their full allotment of natural gas can cause costly damage to parts and equipment if gas flow is interrupted at a citical moment or, it may even cause a complete plant shutdown.

Utility firms, aware of the dilemma of industrial users, encourge the installation of some sort of standby system in the event natural gas is interrupted. As an incentive, most utility companies offer what is known as an "interruptable" rate to those with standby systems. This rate, usually substantially lower than the "firm" rate, is enjoyed year around by the industrial user for the possiblity of having their natural gas supply interrupted or even shut off. Should the utility company give notice of an interruption (sometimes less than 24 hours), the industrial facility continues operation by switching to their standby system.

Since the "interruptable rate" is enjoyed every day of the year, not just cold months when gas is most critical, it 's possible for an industry to amortize the whole cost of a standby facility in less than two years.

WHAT IS A PEAKLOAD SHAVING PLANT?

Peakload Shaving is a term used by the utility companies. As we said before, the utility purchase a certain amount of gas over a fixed period of time. The best laid plans cannot take into consideration unexpected cold spells, a burst line or other things that could happen to disrupt the planned quota.

If the utility should need more gas than it has contracted, they pay a premium price , if it is available. So, to insure

extra gas and avoid premium price for gas above the contracted amount, many utility companies use propane mixed with air to duplicate the BTU content of natural gas. This mixed gas is then used to supplement the utility's gas supply, allowing a more consistent fuel rate from their supplier and help meet peak demand loads.

WHO USES A STANDBY PLANT?

Utilities and municipalities, clay product manufacturers, glass makers, bakeries, metal processing firms, textile industries, chemical companies or, any industrial firm that uses natural gas in any of it's processes.

WHAT IS LP-GAS?

LP-Gas or LPG is the abbreviation for liquefied petroleum gas with the most common known being propane and butane. At normal atmospheric pressure and temperatures, LP-Gas is in the gaseous state. However, it is converted to the liquid state with moderate pressure and that is why LPG is transported and stored in tanks or containers having at least 250 PSI working pressure.

The main source of LPG is natural gas and crude oil mixtures as they come from active oi. and natural gas wells. Though propane is similar to natural gas (methane). propane has 2520 BTU per cubic foot compared to 1050 BTU per cubic foot for natural gas. That is why propane, when mixed in proper proportion with air, is an excellent supplement or replacement to natural gas.

Physical Properties of Propane:

a)BTU per gal= 91,500
b)Specific Gravity of liquid @ 60 Deg F.(Water=1.0) = .509
c)Specific Gravity of gas @ 60 Deg.F. (Air=1.0) =1.522
d)Cubic feet gas per gal.= 36.20
e)Boiling Point of Liquid @ Sea Level when released to air = -44 Deg, F.
f)Vapor Pressure @ 60 Deg. F. = 92 PSI
g)Vapor Pressure @ 100 Deg. F.= 172 PSI

WHAT IS A PROPANE VAPORIZER?

A propane vaporizer is actually a boiler. Instead of boiling water, it boils propane. It may sound strange that heat is required to vaporize propane when propane will boil at -44 degrees F. but, when propane vaporizes by expansion alone, it causes a refrigeration action that would freeze valves and burner nozzles. Therefore, heat is required to offset the refrigeration action.

There are two types of propane vaporizers . A direct fired type uses a portion of the propane it vaporizes to supply the heat for the vaporizatoin process. The indirect fired type uses an outside source of heat, such as steam or hot water, to vaporize the propane.

MIXERS AND BLENDERS

After the liquid propane has been vaporized, it needs to be mixed in proper proportion with air to duplicate the characteristics of natural gas. This is where mixers and blenders come in.

There are several methods to mix air and propane vapor but, probably the most simple is by using a venturi and nozzle. This method, as well as other methods, hold very accurate air-fuel ratios through a narrow range. This type mixer does not generally require compressed air for operation. The mixture of air/vapor is fed into a surge tank, where it is maintained at a set pressure ,and then drawn from the surge tank for use. This type system is usually recommended for intermittent periods of use and are simple to operate.

Blenders and modulating proportioning mixers are more complex but, are accurate and capable of mixing propane with air in large volumes at high pressure. These systems are recommended for continuous or long periods of useage and are ideally suited for peakload shaving and larger installations.

Regardless of the type vaporizer and mixer, a standby system can be designed for the requirement of the small user or large industrial and utility users. In this day of uncertain oil prices and supplies, a standby system should be considered by all natural gas users. A simple analogy is that - we keep a spare tire for our automobile in the event of a flat - a standby system is a spare fuel supply in the event natural gas is interrupted or demand cannot be met.

ALTERNATE ENERGY SYSTEMS' VAPORIZERS

Alternate Energy Systems manufactures a complete line of liquid propane vaporizers (direct fired, indirect fired) in capacities from 40 GPH to 5500 GPH. The vaporizers are manufactured to the rigid codes of the American Society of Mechanical Engineers (ASME), latest edition of NFPA #58 and, approved for Factory Mutual (FM) or Industrial Risk Insurers (IRI) installations .

We, as a mnufacturer, go far beyond the requirementss and codes and are continually working to produce equipment with the most modern engineering techniques available.

DIRECT FIRED VAPORIZERS

Requiring no electrical source for operation, the direct fired vaporizer is manufactured in capacities of 40, 80 and 120 gallons per hour propane vaporization at zero degrees F. inlet temperature.

Featuring a unique primary and secondary air burner that assures quick ignition, there are no openings or louvers at the base of the unit which could cause pilot outage problems. The units are manufactured with a bronze liquid inlet valve, dual liquid level control to prevent liquid carryover and stainless steel ball float with 1500 PSI pressure rating. Encased in a durable steel sheet metal cabinet, the door is easily removed for simple access and maintenance to burner assembly and temperature control valve.

The vaporizing tube and all propane piping conform to the standards of Section VIII, Division I of the ASME Boiler & Pressure Vessel Code, NFPA #58, and are approved for Factory Mutual (FM) and Industrial Risk Insurers (IRI) installations. Models AE-40 and AE-80 are also approved by Underwriter's Laboratories of Canada (ULC).
Model Number (AE) designates gallons per hour propane vaporization at 0 degrees F. inlet temperature.

WATER BATH VAPORIZERS

The horizontal water bath vaporizers are rectangular in design, top and sides insulated with fiber board insulation to hold water bath temperature and, covered with aluminum panels. The vaporizing tube bundle and all propane piping conform to the standards of the ASME Boiler and Pressure Vessel Code, NFPA #58 and are approved for Factory Mutual (FM) and Industrial Risk Insurers (IRI) installations.

Using a mixture of water and antifreeze solution as a heat exchange medium, the units are skid mounted, factory tested prior to shipment, ready for connection to properly sized electrical, liquid propane inlet and vapor outlet. Model number (WB) designates gallons per hour propane vaporization at 0 degrees F. inlet temperature.

MODEL WB-200 THRU WB-350

These models are manufactured with a venturi type burner, standing pilot and thermocouple with burner controls enclosed for protection from the elements. Standard safety devices include: (1) failsafe burner and pilot controls, (2) high water bath temperature limit, (3) low water limit, (4) low propane temperature switch, and (5) water temperature control. Electrical requirements: 15 amp, 120 volt, single phase.

MODEL WB-450 THRU WB-2000

These models are manufactured with a power type burner, controlled by a flame safeguard system, with burner controls enclosed for protection from the elements. Complete with first and second stage burner regulation, standard safety devices include: (1) high water bath temperature safety, (2) low water level safety, (3) flame failure lockout, (4) combustion air flow switch, (5) low burner gas pressure safety, and (6) high burner gas pressure safety. Failure on any of these conditions will cause the system to lockout and sound an alarm. Electrical requirements : 120 volt, single phase.

MODEL WB-2200 THRU WB-5500

These models are manufactured with a power type burner controlled by a Programmer with burner controls enclosed for protection from the elements. Complete with first and second stage burner regulation, standard safety devices include: (1) high water bath temperature safety, (2) low water level safety, (3) flame failure lockout, (4) combustion air flow switch, (5) low burner gas pressure safety and (6) high burner gas pressure safety. Failure on any of these conditions will cause the unit to lockout and sound an alarm. Electrical requirements: 460 volt, three phase with Alternate Energy Systems' supplying a control circuit transformer.

STEAM VAPORIZERS

Alternate Energy Systems has a complete line of vertical steam vaporizers in capacities of 55 to 6650 gallons per hour. The steam tube is of multipass designed to transfer maximum heat to the liquid with tube bundle and all propane piping conforming to the ASME Boiler and Pressure Vessel Code.

The steam vaporizers are complete with steam temperature regulator, electric liquid level control, liquid inlet valve, solenoid valve, steam trap and steam back check valve.

ELECTRIC VAPORIZERS

Alternate Energy Systems has just introduced it's newest unit, the LECTRA PAK vertical electric vaporizer. Utilizing electric resistance heaters and designed for safety and dependability, the system meets all requirements of NFPA Pamphlet #58.

LECTRA PAK is complete with liquid inlet solenoid valve approved for LP-Gas at 250 PSIG and ASME approved safety relief valve. All electrical meets the requirements of NEC 70 for Class I, Group D, Division II locations. The vaporizer has full 100% turndown capability and is available with optional remote start.

Manufactured of an aluminum block with a 1" (2.54 cm) diameter steel pressure tube to prevent the LPG from contacting the aluminum, the unit features cast-in electric resistance heating elements. Heat is transferred from the aluminum, through the steel pressure vessel tube and, promotes vaporization of the liquid propane. A thermocouple sensing the temperature of the core, cycles the resistance heater OFF/ON to maintain vapor temperature between 100 - 160 degrees F. (37.8 to 71 degrees C.)

ALTERNATE ENERGY SYSTEMS' MIXERS

Alternate Energy Systems, Inc. manufactures a complete line of propane-air blending and mixing systems ranging in capacity from 3.5MM BTU to 500MM BTU per hour.

Our complete line of venturi mixers and proportional blenders utilize the finest quality material and knowledge to meet the requirement of agencies and insurance companies governing the LPG industry.

VENTURI MIXERS

Intended for outside service, these mixing systems require 115 volt, single phase electrical for operation. Using pressurized propane vapor through a venturi arrangement to inspirate air, the BTU content of the mixture is determined by the regulated propane vapor pressure. With the gas system governing the frequency of operation, the venturi mixer cycles on/off by the use of pressure switches.

The skid mounted systems are complete with surge tank, blow down, safety relief valve protection, high and low mix gas safety, low propane pressure safety and dual check valve system. Solenoid valves are explosion proof and pressure switches are of standard type.

Manufactured to the requirements of the ASME Code, latest edition of NFPA #58 and, approved for Factory Mutual (FM) or Industrial Risk Insurers (IRI) installations, model number (HVS) of the venturi system designates millions of BTU per hour propane-air mixture.

Standard Models have an output pressure of 5 PSI propane-air mixture with pressures of 4-9 PSI obtained by factory adjustment. *High Pressure Models* with output pressure from 10 to 50 PSI propane-air mixture are available and require compressed air for operation.

PROPORTIONAL BLENDERS

The utter simplicity of Alternate Energy Systems' proportional blending systems provide the ultimate in reliability and operation. Manufactured to meet or exceed industry specifications set forth by the ASME Boiler and Pressure Vessel Code and latest edition of NFPA #58, these systems require compressed air for operation. Using a uniquely designed rotatable piston valve to control flow, mixed gas and regulate the mixed gas BTU content, these units are virtually maintenance free and eliminate problems and restrictions commonly found with diaphragms and piston rings. Once set, the blender will mix two gases at the same ratio regardless of downstream demand.

The units are supplied with propane regulator, compressed air regulator, safety relief valve protection on the mixed gas line and check valves on the air and propane inlet to prevent backflow. Standard units include general purpose first outage control panel and are designed to shut down in the event of (1) high mixed gas pressure, (2) low mixed gas pressure, (3) low propane vapor pressure, (4) low air pressure, and (5) excess differential pressure (gas-to-air). Failure on any of these conditions will cause the system to shut down and cause of failure will be indicated on the first outage control panel. The blender remains in shutdown status until manually restarted.

When used with the optional "Accu-Blend" system (a solid state controller combined with a signal from a gravitometer, calorimeter, Wobbe Index Meter or other BTU measuring device), the system will automatically control the BTU output.

ALTERNATE ENERGY SYSTEMS' MODULE UNITS

Alternate Energy Systems, Inc. manufactures the most complete line of packaged standby equipment available in the industry. These packages, complete with interconnecting piping and wiring, are ready for connection to liquid propane inlet, properly sized electrical and mixed gas outlet.

These skid mounted packages can be factory or field modified to accept flow control systems, specific gravity meter, special annunciator panels or large number of other options to allow the customization of any system to meet any specific specification.

DIRECT FIRED VAPORIZER W/VENTURI MIXER MODULE

These skid mounted, packaged systems utilize a direct fired vaporizer (or combination of vaporizers) with venturi type mixing system. Designed for capacities ranging from 3.5MM BTU to 30MM BTU per hour, the units are manufactured to meet or exceed requirements of the ASME Pressure Vessel Code and latest edition of NFPA Pamphlet #58. Intended for intermittent service, the units are approved for Factory Mutual (FM) or Industrial Risk Insurers (IRI) installations.

Standard design output pressure is 5-9 PSI. Higher pressures of 10-50 PSI are also available and require compressed air for operation. The vaporizer model number (AE) designates gallons per hour propane vaporization at 0 degrees F. inlet temperature and the mixer model (HVS) designates millions of BTU per hour propane-air mixture. Models with capacity requirements of more than 120 GPH use a series of two or more vaporizers manifolded for correct GPH. Electrical requirement: 115 volt, single phase current.

WATER BATH VAPORIZER W/VENTURI MIXER PACKAGE

These skid mounted, packaged systems utilize a horizontal water bath type vaporizer with venturi type mixing system and are designed for capacities of 10MM BTU to 100MM BTU per hour. Manufactured to meet or exceed requirements of the ASME Pressure Vessel Code and latest edition of NFPA Pamphlet #58, they are approved for Factory Mutual (FM) or Industrial Risk Insurers (IRI) installations.

Standard design output pressure is 5-9 PSI propane-air mixture with high pressure units of 10-50 PSI available upon request (Note: High Pressure units require compressed air for operation). Vaporizer model number (WB) designates gallons per hour propane vaporization at 0 degrees F. inlet temperature and mixer model number (HVS) designates millions of BTU per hour propane-air mixture. Model number or capacity requirement governs type of vaporizer burner and safety features. (Refer to Section I (Vaporizers) and Section II (Mixers).

WATER BATH VAPORIZER W/PB MIXER PACKAGE

These skid mounted, packaged systems utilize the water bath vaporizer and proporational blending system and are designed for capacities of 30MM BTU to 500MM BTU per hour. Complete with interconnecting piping and wiring, they are ready for connection to liquid propane inlet, properly sized electrical and mixed gas outlet.

Requiring clean, dry compressed air for operation, the blending system is mounted on top of the water bath vaporizer. Applicable for continuous duty or total stand-by the units are designed for 50:1 turndown ratio. Complete with first outage annunciation, the systems have automatic safety shutdown with manual re-start.

The vaporizer model number (WB) designates gallons per hour propane vaporization at 0 degrees F. inlet temperature and the blender is sized according to millions of BTU per hour propane-air mix requirements. Refer also to Section I (Vaporizers) and Section II (Mixers).

OTHER MODULE UNITS

Many of the vaporizers and mixing/blending systems manufactured by Alternate Energy Systems can be manufactured inside portable, prefabricated buildings; palletized on structural steel skids to include compressors or, customized to meet the requirement of any user. For more information, contact your area distributor or factory.

ALTERNATE ENERGY SYSTEMS' ACCESSORIES

Alternate Energy Systems has a complete line of accessories and LPG equipment to compliment and complete any propane standby system.

Our railtowers are factory fabricated and shipped in three sections for ease in field installation. We manufacture or carry a complete line of compressors, pump packages, valves, controls, metering systems, flow recorder/controller systems and tie-in assemblies.

All equipment manufactured by Alternate Energy Systems is available in various configurations and with various options. Please consult your area distributor or the factory for your specific requirements.

Alternate Energy Systems reserves the right to make changes or add improvements without notice and without accruing any obligation to make such changes or add such improvements to products sold previously.

DEFINITIONS

Several characteristics affect LPG as a replacement or supplemental fuel. These include:

a) Flame Velocity and Color
b) Specific Gravity
c) Calorific Value
d) BTU Measurement (Wobbe Index)

1. FLAME VELOCITY/COLOR

Because of the number of carbon atoms in propane, propane-air mixtures produce a flame that is more yellow in color. However, the yellow tips are not of consequence and do not affect burner operation or efficiency. Flame velocities of LPG are near equal to that of natural gas and thus, there is no significant flame lift differences between natural gas and propane-air mixtures.

2. SPECIFIC GRAVITY

The density of a gas, relative to air, is called specific gravity. Since air has a specific gravity of 1.0 and propane a specific gravity of 1.5, propane-air mixtures have a specific gravity greater than 1.0.. The following chart indicates heat value in BTU/Cu/Ft (KCal/MN3) and the specific gravity of various propane-air mixtures.

PROPANE-AIR MIXTURES

BTU/FT3 (KCAL/NM3)	% PROPANE BY VOLUME	% AIR BY VOLUME	% OXYGEN BY VOLUME	SPECIFIC GRAVITY OF MIXTURES
1700 (15,130)	66.67	33.33	6.694	1.349
1650 (14,685)	64.70	35.30	7.378	1.338
1600 (14,220)	62.74	37.26	7.787	1.328
1550 (13,795)	60.78	39.22	8.197	1.318
1500 (13,350)	58.82	41.18	8.606	1.308
1450 (12,950)	56.86	43.14	9.016	1.297
1400 (12,450)	54.90	45.10	9.246	1.287
1350 (12,015)	52.94	47.06	9.835	1.277
1300 (11,580)	50.98	49.02	10.245	1.267
1250	49.02	50.98	10.654	1.357

Different heat values result primarily from differences in specific gravity. The higher the specific gravity, the heavier the gas. Since burner orifices, flow meters, regulators, etc. have fixed openings, they allow less flow of heavier gas and therefore must have a higher heat value to provide the same energy input as a lighter gas.

Most natural gas has an average heat value of approximately 1050 BTU/Cu Ft (9350 KCAL/MN3) and a specific gravity of .6. Compatible propane-air replacement have a heat value of 1400 BTU/Cu Ft (12,467 KCAL/MN3) and a specific gravity of 1.287.

3. CALORIFIC VALUE

The calorific value is the measurement of the amount of heat or energy produced and is measured either as gross calorific value or net calorific value. The difference being the latent heat of condensation of the water vapor produced during the combustion process. Gross calorific value assumes all water produced during the combustion process is condensed. Net calorific value assumes the water leaves with the combustion products without being condensed.

Since most gas burning appliances cannot utilize the heat content of the water vapor, gross calorific value is of little interest. Fuel should be compared based on the neat calorific value and this is especially true for natural gas since the increased hydrogen content results in high water formation during combustion.

4. WOBBE INDEX

The Wobbe Index is, a critical factor when analyzing propane-air plant requirements, is a function of gas quality and allows matching one gas (in this case, natural gas) to a replacement gas (in this case, propane-air). If the two different gases have an identical Wobbe Index, they will produce an equal amount of heat and combustion products and, will require the same amount of combustion air. Burners adjusted for a specific calorific value and are provided a replacement of a lower Wobbe Index, result in minor combustion changes. Substituting a gas for one with a higher Wobbe Index generally allows a narrow acceptance range. Flame characteristics determine the acceptance range for the replacement gas.

ALTERNATE ENERGY SYSTEMS, INC.
PEACHTREE CITY, GEORGIA

THEORETICAL COMPATIBLE MIXTURES

Based on Propane S..G.U. = 1.53 2516 BTU Cu/Ft
Equivalent heat input @ equal pressure and flows proportional to square root of ratio of specific gravity of mixture to natural gas.

S.G.U.	GROSS HEAT BTU/CU FT	% PROPANE	% AIR	S.G.U.	GROSS HEAT BTU/CU FT
	800	47.54	52.46	1.252	1196
	850	50.87	49.13	1.270	1280
	900	54.24	45.76	1.287	1365
	950	57.65	42.35	1.306	1450
.056	1000	61.11	38.89	1.324	1538
	1050	64.62	35.38	1.342	1626
	1100	68.16	31.84	1.361	1715
	1150	71.76	28.24	1.380	1805
	1200	75.40	24.60	1.400	1897
	800	46.62	53.38	1.247	1173
	850	49.88	50.12	1.264	1254
	900	53.18	46.82	1.282	1338
	950	56.52	43.48	1.300	1422
.058	1000	59.90	40.10	1.317	1507
	1050	63.33	36.67	1.336	1593
	1100	66.80	33.20	1.354	1681
	1150	70.32	29.68	1.373	1769
	1200	73.88	26.12	1.392	1869
	800	45.76	54.26	1.243	1151
	850	48.95	51.05	1.259	1232
	900	52.18	47.82	1.276	1313
	950	55.45	44.55	1.294	1395
.060	1000	58.76	41.24	1.311	1478
	1050	62.12	37.88	1.329	1563
	1100	65.51	34.49	1.347	1648
	1150	68.95	31.05	1.365	1735
	1200	72.43	27.57	1.384	1822
	800	44.93	55.07	1.238	1130
	850	48.06	51.94	1.255	1209
	900	51.23	48.77	1.272	1289
	950	54.43	45.57	1.288	1369
.062	1000	57.68	42.32	1.306	1451
	1050	60.97	39.03	1.323	1534
	1100	64.29	35.71	1.341	1618
	1150	67.66	32.34	1.359	1702
	1200	71.07	28.93	1.377	1788
	800	44.15	55.85	1.234	1111
	850	47.22	52.78	1.250	1188
	900	50.32	49.68	1.267	1266
	950	53.47	46.53	1.283	1345
0.64	1000	56.65	43.35	1.300	1425
	1050	59.87	40.13	1.317	1506
	1100	63.13	36.87	1.335	1588
	1150	66.44	33.56	1.352	1672
	1200	69.78	30.22	1.370	1756
	800	43.41	56.59	1.230	1092
	850	46.42	53.58	1.246	1168
	900	49.47	50.53	1.262	1245
	950	52.55	47.45	1.262	1322
0.66	1000	55.68	44.32	1.295	1401
	1050	58.84	41.16	1.312	1480
	1100	62.04	37.96	1.329	1561
	1150	65.27	34.73	1.346	1642
	1200	68.55	31.45	1.363	1725

ALTERNATE ENERGY SYSTEMS, INC.
PEACHTREE CITY, GEORGIA

SPECIFIC GRAVITY AND HEAT CONTENT BY VOLUME OF LP GAS-AIR MIXTURES

Based on Propane S.G.U. = 1.53 2516 BTU/Cu Ft
Butane S.G.U. = 2.00 3280 BTU/Cu Ft

PROPANE-AIR MIXTURES

% PROPANE	% AIR	S.G.U.	GROSS HEAT BTU/CU FT
100	0	1.530	2516
95	5	1.504	2390
90	10	1.477	2264
85	15	1.451	2139
80	20	1.424	2013
75	25	1.398	1887
70	30	1.371	1761
65	35	1.345	1635
60	40	1.318	1510
59	41	1.313	1484
58	42	1.307	1459
57	43	1.302	1434
56	44	1.297	1409
55	45	1.292	1384
54	46	1.286	1359
53	47	1.281	1333
52	48	1.276	1308
51	49	1.270	1283
50	50	1.265	1258
45	55	1.239	1132
40	60	1.212	1006
35	65	1.186	881
30	70	1.159	755
25	75	1.133	629
20	80	1.106	503
15	85	1.080	377
10	90	1.053	252
5	95	1.027	126
0	100	1.000	0

BUTANE-AIR MIXTURES

% BUTANE	% AIR	S.G.U.	GROSS HEAT BTU/CU FT
100	0	2.000	3280
95	5	1.950	3116
90	10	1.900	2952
85	15	1.850	2788
80	20	1.800	2624
75	25	1.750	2460
70	30	1.700	2296
65	35	1.650	2132
60	40	1.600	1968
59	41	1.590	1935
58	42	1.580	1902
57	43	1.570	1870
56	44	1.560	1837
55	45	1.550	1804
54	46	1.540	1770
53	47	1.530	1738
52	48	1.520	1706
51	49	1.510	1672
50	50	1.500	1640
49	51	1.490	1607
48	52	1.480	1574
47	53	1.470	1542
46	54	1.460	1509
45	55	1.450	1476
40	60	1.400	1312
35	65	1.350	1148
30	70	1.300	984
25	75	1.250	820
20	80	1.200	656
15	85	1.150	492
10	90	1.100	328
5	95	1.050	164
0	100	1.000	0

ALTERNATE ENERGY SYSTEMS, INC.
PEACHTREE CITY, GEORGIA

COMPARATIVE THERMAL VALUE OF FUELS

NATURAL GAS....................100,000 BTU's = 1 Therm
FUEL OIL....................42 Gallons = 1 Barrel

GAS CONVERSION FACTORS

1 Cubic Foot (CF)....................Approx. 1,000 BTU's
100 CF....................100,000 BTU's
1 Therm....................100,000 BTU's
10 Therms....................1 Decatherm (DTH)
1 DTH....................1,000,000 BTU's
1 DTH....................1 MM BTU

APPROXIMATE CONVERSION

Propane/Gallon....................91,500 BTU's = .915 Therms/Gallon
Butane/Gallon....................103,000 BTU's = 1.03 Therms/Gallon
#2 Heating Oil/Diesel/Gallon..........138,500 BTU's = 1.385 Therms/Gallon
#6 Fuel Oil/Barrel....................6,350,000 BTU's = 63.5 Therms/Barrell
Coal (Short Ton)....................21,900,000 BTU's = 219 Therms/Short Ton

1 Truck & Trailer of Propane (9,300 gallons)........... = 8,510 Therms
1 Truck & Trailer of Butane (9,000 gallons)............ = 9,270 Therms
1 Truck & Trailer of Diesel (8,000 gallons)............... = 11,080 Therms
1 Truck & Trailer of #6 Fuel Oil (7,000 gallons)..... = 10,500 Therms

CONVERT CENTS/GALLON TO $/MM BTU

MULTIPLY CENTS/GALLON BY:

Ethane....................15.24 Gallons/MM BTU
Propane....................10.93 Gallons/MM BTU
Normal Butane....................9.71 Gallons/MM BTU
Iso-Butane....................10.12 Gallons/MM BTU
Mixed Butane (75/25)....................9.81 Gallons/MM BTU
Natural Gasoline....................8.00 Gallons/MM BTU
#2 Oil....................7.22 Gallons/MM BTU

CONVERT $/Bbl TO $/MM BTU

DIVIDE $/Bbl BY:

#6 Oil....................6.35 MM BTU/Barrel
#6 Oil....................151,190 BTU/Gallon

PHYSICAL PROPERTIES OF PROPANE

	Propane
Formula	C_3H_8
Molecular Weight	44.097
Melting (or Freezing) Point, °F	-305.84
Boiling Point, °F	-44
Specific Gravity of Gas (Air = 1.00)	1.52
Specific Gravity of Liquid 60°F/60°F (Water = 1.00)	0.588
Latent Heat of Vaporization at Normal Boiling Point BTU/lb.	183
Vapor Pressure, lb./sq. in. Gauge at 60°F	92
Lbs. per Gallon of Liquid at 60°F	4.24
Gallons per lb. of Liquid at 60°F	0.237
BTU per lb. of Gas (gross)	21591
BTU per cu. ft. Gas at 60°F and 30" Mercury	2516
BTU per gal. of Gas at 60°F	91547
Cu. ft. of Gas (60°F, 30" Hg)/Gal. of Liquid	36.39
Cu. ft. of Gas (60°F, 30" Hg)/Lb. of Liquid	8.58
Cu. ft. of Air Required to Burn 1 cu. ft. Gas	23.87
Flame Temperature, °F	3595
Octane Number (Iso-Octane = 100)	125

CONSTANT MEASUREMENTS

Unit of Measure	BTU	KWH	Therm	Decitherm
BTU	1	.000293	.00001	.0001
KWH	3,413	1	.00341	.0341
Therm	100,000	29.3	1	10
Decitherm	10,000	2.93	.1	1

PROPANE EQUIVALENTS

Unit of Measure	BTU	Pound	Therm	Decitherm	Cu. Ft.	Gallon
Pound	21,591	1	.216	2.16	8.58	.239
Therm	100,000	4.622	1	10	39.7	1.10
Decitherm	10,000	.4622	.1	1	3.9	.110
Cu. Ft.	2,516	.1164	.025	.25	1	.027
Gallon	91,547	4.24	.916	9.16	36.39	1

NATURAL GAS

Unit of Measure	BTU	Pound	Therm	Decitherm	Cu. Ft.	Gallon
Cu. ft.	1,040		.011	.11	1	

These figures represent average properties of propane.

ALTERNATE ENERGY SYSTEMS, INC.
P.O. BOX 2469 210 PROSPECT PARK
PEACHTREE CITY, GEORGIA 30269

TELEPHONE: 404-487-8596
FAX: 404-631-4306
TELEX: 5101007858 AESGA UD

SPECIFICATION SHEET
MODEL WB-2500
HORIZONTAL WATER BATH PROPANE VAPORIZER

TYPE: Horizontal Water Bath Indirect Fired Propane Vaporizer
CAPACITY: 2500 Gallons Per Hour Propane Vaporization at 0 Degrees F. Inlet
WATER CAPACITY: 1398 Gallons
BURNER DESIGN: 3,000,000 BTU Per Hour/Forced Draft
DESIGN TEMPERATURE: 650 Degrees F. Inlet
DESIGN PRESSURE: 250 PSIG

MANUFACTURED CONSTRUCTION: Vaporizing Tube conforms to ASME Boiler & Pressure Vessel Code, Section VIII, Division I. Conforms to latest edition of NFPA #58. Features Power Type Burner; Electronic Flame Safeguard System and Enclosed Burner Controls.

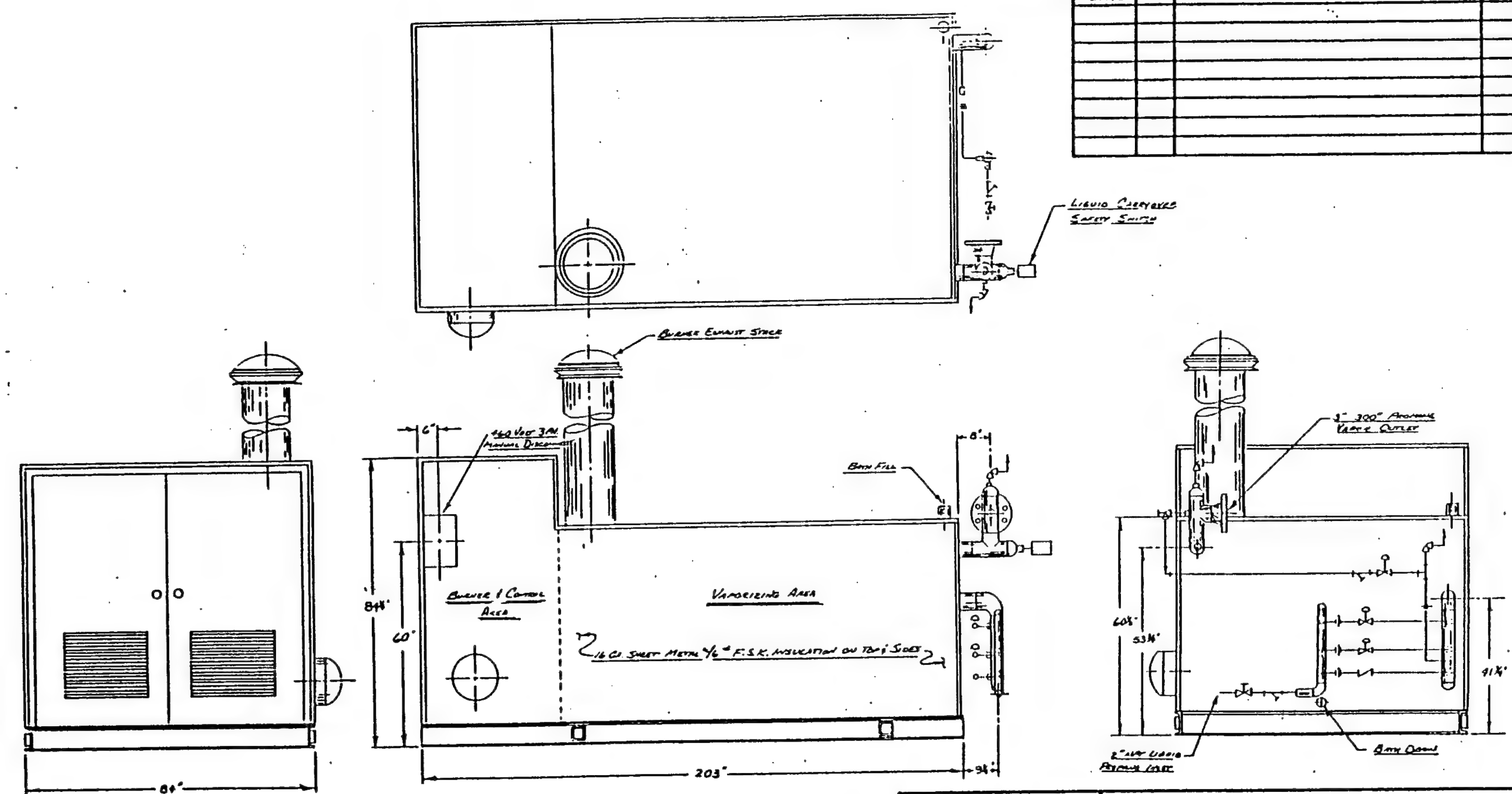
APPROVALS: Factory Mutual (FM) and Industrial Risk Insurers (IRI).

STANDARD SAFETY FEATURES:
- Flame Failure Safety Shut Down
- Low Water Level Cut Off
- Liquid Carryover Protection (Low Vapor Temp)
- Relief Valve Protection/Vaporizer Coil & Burner Train
- Electronic Flame Safeguard
- High Water Bath Temperature Limit
- Low Burner Gas Pressure Safety
- High Burner Gas Pressure Safety

LIQUID INLET CONNECTION: 2" FNPT
VAPOR OUTLET CONNECTION: 3" 300# Raised Face Flange
ELECTRICAL REQUIREMENT: 460V, Three Phase; 60 Cycle, 20 Amp
SKID DIMENSIONS: 84" W x 206" L
DRY WEIGHT: 14,500#
OPTIONS AVAILABLE: ASME "U" Stamp
National Board Registration
Vapor Outlet Valve
Second Stage Regulator

All equipment manufactured and sold by Alternate Energy Systems is covered by our standard equipment warranty against defects in material or workmanship as outlined in our full equipment warranty. All units are primed, painted and factory tested prior to shipment.

DATE	NO.	REVISION RECORD	DR.	CK.



WATER CAPACITY - 2,200 GALLONS
DRY WEIGHT - 14,500 POUNDS
VAPORIZER CAPACITY -
2,500 GPH @ 0°F
2,400 GPH @ -20°F

Alternate Energy Systems, Inc.		
DATE 5-15-84	SCALE NONE	DRAWN BY MA / APPROVED BY
TITLE MODEL WB-2500 VAPORIZER - ELEVATION		
		DRAWING NO. C-2018-OR

AF 172580

DRAFTRACE 250

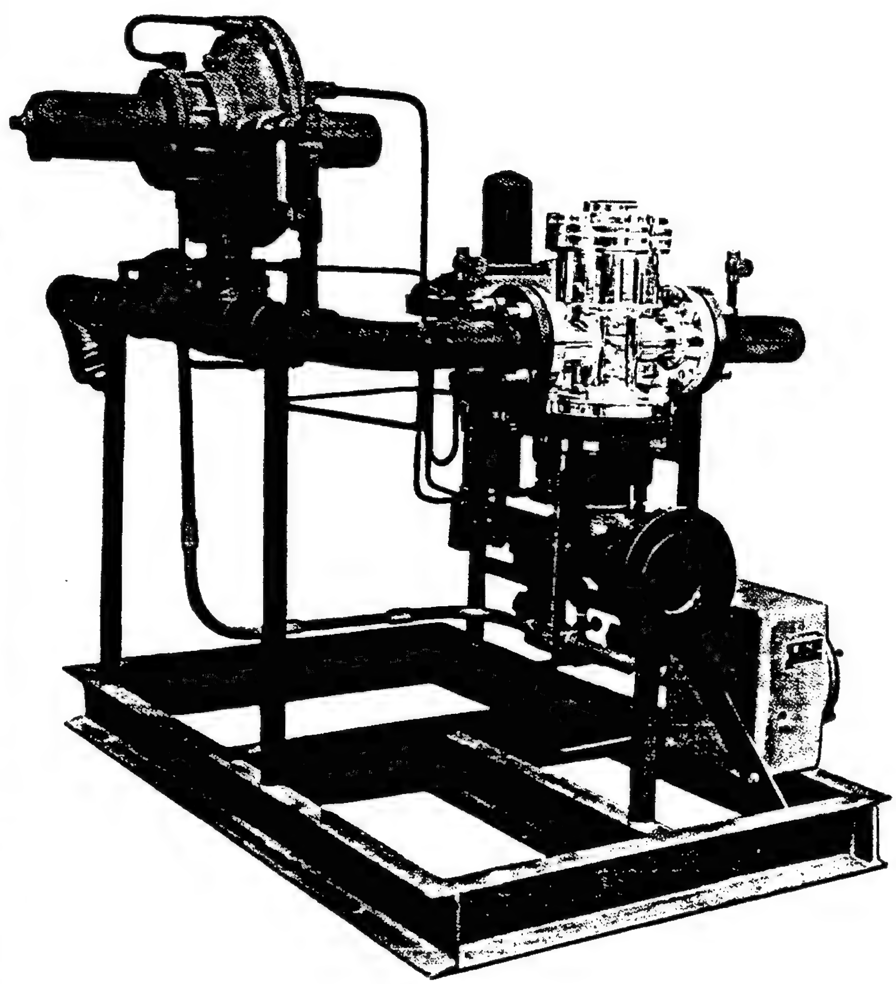
THE POM SYSTEM

Alternate Energy Systems

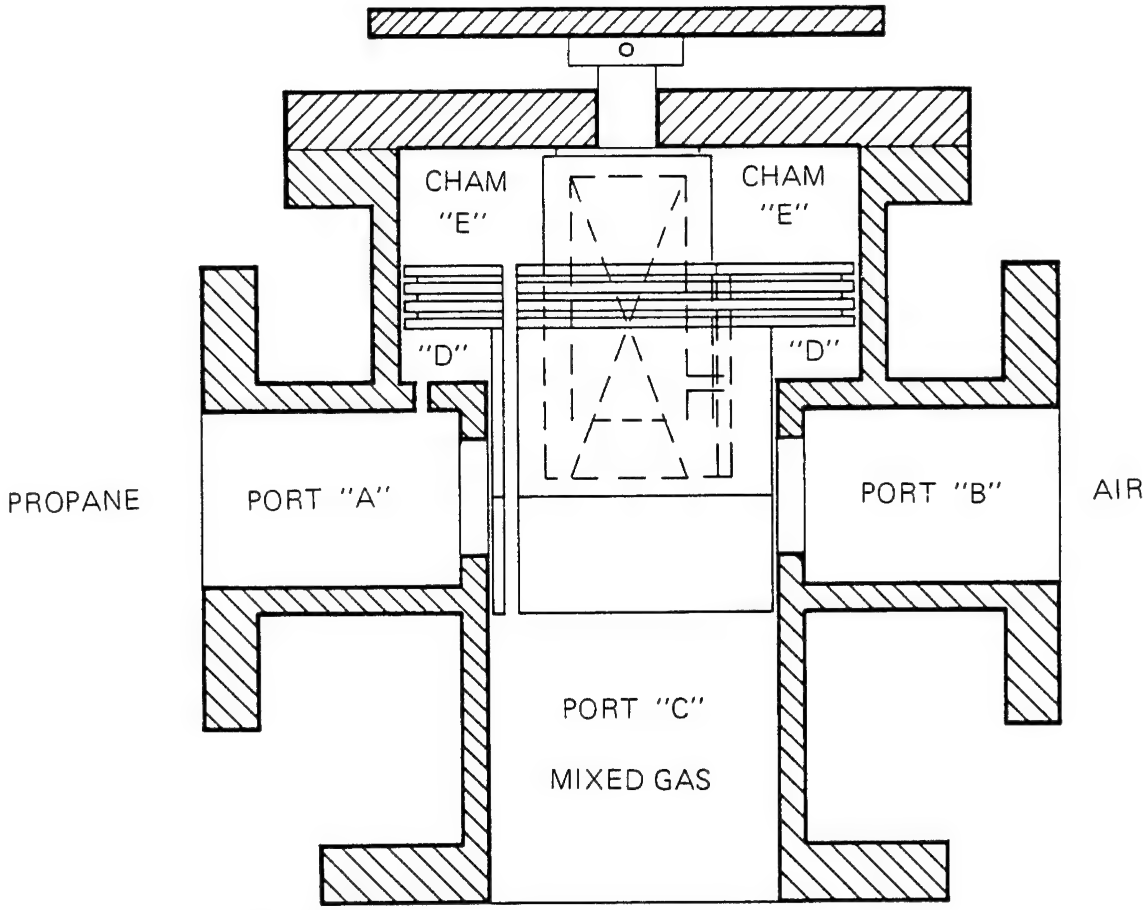
Telephone 404 / 487-8596
P.O. Box 2469 Peachtree City, Ga. 30269

MIXES AIR AND PROPANE TO DUPLICATE NATURAL GAS. ONCE SET, THE MIXTURE REMAINS THE SAME. A SIMPLE SYSTEM THAT CAN BE EASILY SERVICED WITH SIMPLE TOOLS. MAY BE COMBINED WITH A ACCUBLEND CONTROL SYSTEM.

ALTERNATE ENERGY SYSTEMS RELEASES ITS NEWEST STATE-OF-THE-ART MIXING SYSTEM FOR PROPANE-AIR PEAK SHAVING AND STANDBY SYSTEMS . . . THE POM SYSTEM.



PATENT PENDING



PATENT PENDING

The POM (Piston Operated Mixer) is uniquely designed with a rotatable piston to mix two dissimilar gases without the need for a diaphragm operated control.

The utter simplicity of the POM indicates a mixer that offers the ultimate in reliability and can be manufactured of any material compatible with the medium being blended. Virtually maintenance free, simple maintenance requires removal of the POM cap, removal of the piston and washing it in solvent, wiping out the piston chamber and replacing the piston and cap.

By using a piston, there are no design pressure or temperature restrictions commonly found with diaphragms which have high temperature restrictions or may stiffen and crack in cold temperatures.

Once set the POM will mix two gases at a constant ratio; a propane and air mixture which would be compatible with natural gas regardless of the downstream demand. The POM system is a "pushthru" system. This means that it is not necessary to reduce the air and gas to zero pressure then, compressing both air and gas to the desired pressure. The POM system utilizes the existing pressure in the propane to satisfy most industrial applications.

HOW IT WORKS— The dominant gas (i.e. propane) enters the Mixer at Inlet Port "A". Compressed air enters at Inlet Port "B". Both gases exit together at Exit Port "C".

A small connecting tube connects Inlet Port "A" with Chamber "D" and, another tube connects Chamber "E" (through the piston) with Exit Port "C".

During rests or no flow periods, the piston rests in the closed position. Upon demand for gas, pressure at Exit Port "C" drops slightly and this depression is passed through the piston to Chamber "E". The pressure Inlet Port "A" (dominant gas) is greater and, since this area connects to Chamber "D", the piston will rise and fall with demand changes of pressure drops at Exit Port "C". Thus, the piston can

curately measure the flow of gases regardless of the downstream demand.

RATIO ADJUSTMENT— A segment cut out of the piston matches the edge of the cutouts in Port "A-B". The piston is positioned by a spring fitting between a sliding pinned guide and the top of the piston . A knurled knob, attached to the stem of the guide, easily allows adjustment to be made externally by rotating the guide to restrict either Inlet Port and controls the ratio of gas and air. The piston is designed with a series of grooves called a labyrinth which generates circular "O" rings or vortices which prevents the gases from transferring between the top and bottom chambers and thereby, eliminates the need for a diaphragm or a mechanical seal such as a piston ring.

MIXING SYSTEM . . .

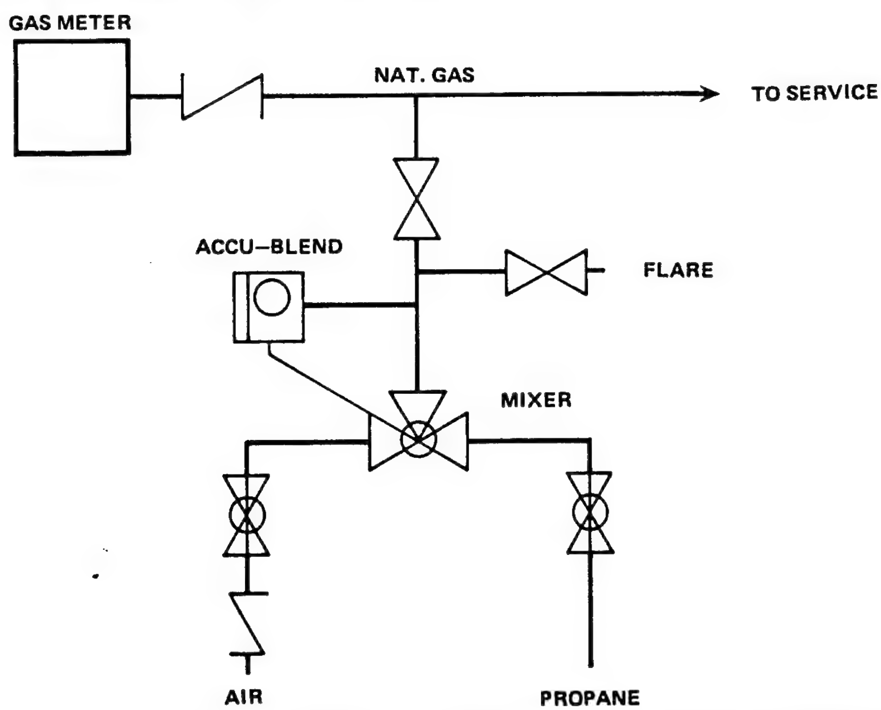
ACCU — BLEND

A solid state controller combined with a 4-20MA signal from a gravitometer, calorimeter, Wobbe Index Meter or any other BTU measuring device will automatically control the BTU output of the new POM blending system.

The POM design also features —

- No rubber diaphragms to dry out and stiffen
- A close tolerance guide for the piston is internal; away from air & gas flow
- Unique air labyrinth piston seal
- The piston does not touch bore
- There are no piston rings to seize; the labyrinth acts as a seal
- There is no external piping. Operating bleeds and parts are integral within the valve thereby reducing damage possibilities
- A proven technology that is used in Rolls Royce and Jaguar engines
- Available state of the art control when combined with the A.E.S. Accu-Blend Control System

P.O.M. SYSTEM WITH ACCU—BLEND CONTROL



POM SYSTEM

MODEL	POM-30	POM-40	POM-60
HEIGHT	50" (127.00 Cm)	50" (127.00 Cm)	50" (127.00 Cm)
WIDTH	48" (122.00 Cm)	48" (122.00 Cm)	48" (122.00 Cm)
LENGTH	60" (152.40 Cm)	70" (177.80 Cm)	80" (203.00 Cm)
VAPOR IN	2" NPT	3" Flg	4" Flg
AIR IN	2" NPT	3" Flg	4" Flg
MIXED GAS OUT	3" Flg	4" Flg	4" Flg
H T TO MIXED GAS FLG CENTER	12" (30.48 Cm)	12" (30.48 Cm)	12" (30.48 Cm)
H T TO AIR AND VAPOR INLET	36" (91.44 Cm)	36" (91.44 Cm)	36" (91.44 Cm)
SHIPPING WEIGHT	600# (272.40 Kg)	800# (363.20 Kg)	1200# (544.80 Kg)

POM SYSTEM FLOW CHART

MIXED GAS PRESSURE **MIXED GAS FLOW SPECIFIC GRAVITY = 1.3**

PSI	Kg/Cm^2	MODEL POM-30	MODEL POM-40	MODEL POM-60
20	1.4	20 MCFH (566 Nm^3/Hr)	70 MCFH (1981 Nm^3/Hr)	160 MCFH (4528 Nm^3/Hr)
40	2.8	30 MCFH (849 Nm^3/Hr)	80 MCFH (2264 Nm^3/Hr)	170 MCFH (4811 Nm^3/Hr)
60	4.2	35 MCFH (990 Nm^3/Hr)	100 MCFH (2830 Nm^3/Hr)	180 MCFH (5094 Nm^3/Hr)
80	5.6	38 MCFH (1075 Nm^3/Hr)	110 MCFH (3113 Nm^3/Hr)	190 MCFH (5377 Nm^3/Hr)
100	7.0	42 MCFH (1188 Nm^3/Hr)	120 MCFH (3395 Nm^3/Hr)	200 MCFH (5660 Nm^3/Hr)
120	8.4	43 MCFH (1216 Nm^3/Hr)	130 MCFH (3679 Nm^3/Hr)	220 MCFH (6226 Nm^3/Hr)
140	9.8	44 MCFH (1245 Nm^3/Hr)	140 MCFH (3962 Nm^3/Hr)	240 MCFH (6792 Nm^3/Hr)
160	11.2	45 MCFH (1273 Nm^3/Hr)	140 MCFH (3962 Nm^3/Hr)	240 MCFH (6792 Nm^3/Hr)
180	12.6	45 MCFH (1273 Nm^3/Hr)	140 MCFH (3962 Nm^3/Hr)	240 MCFH (6792 Nm^3/Hr)
200	14.0	45 MCFH (1273 Nm^3/Hr)	140 MCFH (3962 Nm^3/Hr)	240 MCFH (6792 Nm^3/Hr)
220	15.4	45 MCFH (1273 Nm^3/Hr)	140 MCFH (3962 Nm^3/Hr)	250 MCFH (7075 Nm^3/Hr)
240	16.8	45 MCFH (1273 Nm^3/Hr)	140 MCFH (3962 Nm^3/Hr)	250 MCFH (7075 Nm^3/Hr)
250	17.5	45 MCFH (1273 Nm^3/Hr)	140 MCFH (3962 Nm^3/Hr)	250 MCFH (7075 Nm^3/Hr)

Telephone No. 404/487-8596

Alternate Energy Systems

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5

Industrial Propane Systems

If you were to be designing an industrial fuel supply system, you would start with the same general types of components as are installed in domestic or commercial systems—the tank or tanks, regulators, piping, valves, fittings, safety devices and controls. But they would need to be larger to handle larger demands. And, if demand was to exceed the capability of the propane to vaporize naturally, you would assist nature by installing a heat exchange device known as a vaporizer.

In some cases it might be necessary to add a pump. And if the system was to perform as a standby for interruptible natural gas service, a blender would be needed to reduce the heating value of each cubic foot of propane to make it compatible with natural gas.

A suitable propane-air mixture, matched to the combustion characteristics of the particular natural gas it is to replace, will produce identical results. The equipment in which it is burned won't know the difference between propane-air and natural gas. And this is why propane is the perfect standby fuel for natural gas; no burner changes or adjustments are needed. A plant can switch back and forth from one to the other with no difficulties.

Calculating Interchangeability. Interchangeability of propane with natural gas is, however, a matter of careful and precise blending. The two fuels cannot be interchanged on a Btu-per-cubic-foot basis. Propane aerated to reduce its Btu content to exactly 1000 per cubic foot will not interchange with 1000-Btu natural gas. Specific gravity differentials must also be considered.

The compatibility range has been found to vary from 1196 to 1822 Btu/cu. ft., depending upon specific gravities. For example, a propane-air mixture of 1200 Btu having a specific gravity of 1.24 has been found to be compatible with natural gas of 900 Btu and 0.6 specific gravity, while 1450-Btu propane air with a specific gravity of 1.29 is interchangeable with 1050-Btu, 0.62 specific gravity natural gas. (See *Table 1*.)

In the former case, the correct heating value and specific gravity is achieved by mixing 47% propane with 53% air. In the latter, the ratio is 57% propane and 43% air. (See *Table 2*).

After the propane has been mixed with air in a carefully pre-determined ratio, the propane-air will be fed into the conventional gas system. Many plants have automatic or semi-automatic changeovers; when the gas utility shuts off the supply to the plant it automatically switches over to propane-air. This is highly important in a number of industries where a cool-down in the equipment can be disastrous. In glass kilns, for example, a cool-down can turn the kiln into a molten mess which must be broken up before it can be disposed of. In tile kilns, heat-ups can take an excessively long time, so an interruption in fuel flow can result in a protracted and costly halt in production. Dependable automatic or semi-automatic changeover equipment designed to prevent shutdowns can assure smooth operation.

Many companies in the United States, including automobile manufacturers, use propane air for standby. If their demands are high and the necessary

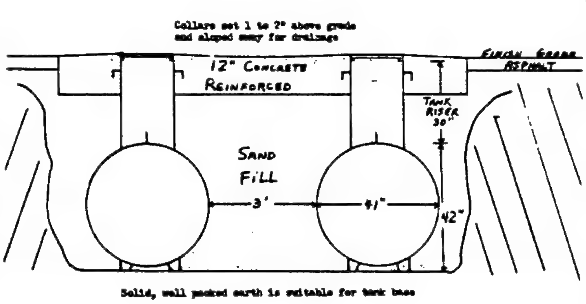


Fig. 1 UNDERGROUND INSTALLATION IN DRIVE OR PARKING LOT

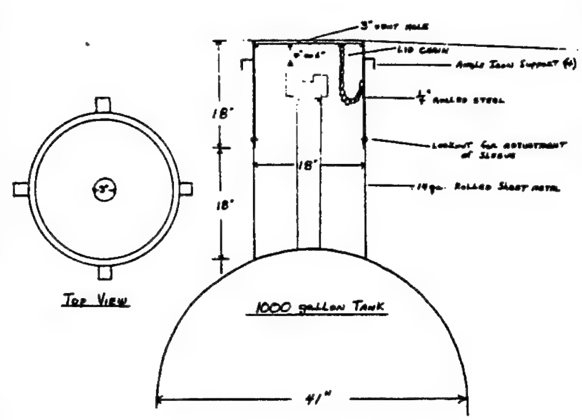


Fig. 2 TRAFFIC COLLAR FOR DRIVE INSTALLATION

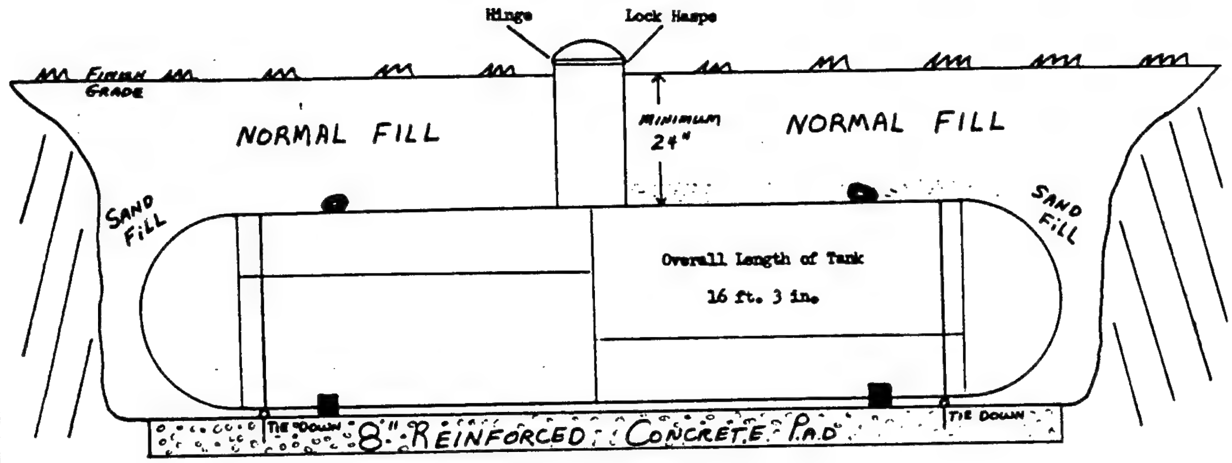


Fig. 3. UNDERGROUND INSTALLATION IN PLANTED AREA

equipment is rather large, the standby plant with mixer and vaporizer may have to be housed in a separate small building. However, for smaller requirements packaged plants, some even skid-mounted, will suffice.

Storage Facilities. As discussed in Chapter 1, codes have been established by the National Fire Protection Association and in many cases adapted intact or with certain changes by local jurisdictions setting minimum clearances for tank installations. By reference again to Chapter 4, you can refresh your memory on the spacing regulations established by NFPA. (Be sure, however, that these are compatible with the local jurisdiction's before using them in your plans.) Containers of 501-2000-gal. capacity must be installed at least 25 ft. from buildings and from property lines that may be built on later; the minimum distance for tanks with over 2000 gals. capacity is 50 ft. from both.

When containers are buried, a minimum distance of 6 inches must be maintained from the top of the container to the grade. Select a site carefully, making sure to locate all buried sewer lines, water lines, drain tiles, buried power lines and gas lines that may be in the area. Do not bury tanks near underground piping or tiles because any leakage from the tank could follow a pipe or tile to a building or low area. Avoid if possible areas that might be subject to flooding; if this is not feasible, make sure the tank is weighted and anchored to prevent its floating in case of high water. All regulator vents and relief valve vents must be high enough to protrude above maximum flood stage.

Although the minimum depth for tank burial is 6 inches, if it is to be placed in a position where it could be subject to abrasive action or physical damage due

Table 1. PROPANE-AIR MIXTURES

Natural Gas Properties		Equivalent Propane-Air Mixture	
BTU/CF	Specific Gravity	BTU/CF	Specific Gravity
900	0.6	1200	1.24
1000	0.61	1400	1.28
1050	0.62	1450	1.29
1100	0.63	1500	1.31
1150	0.65	1560	1.32

Table 2. MIXTURE SPECIFICATIONS

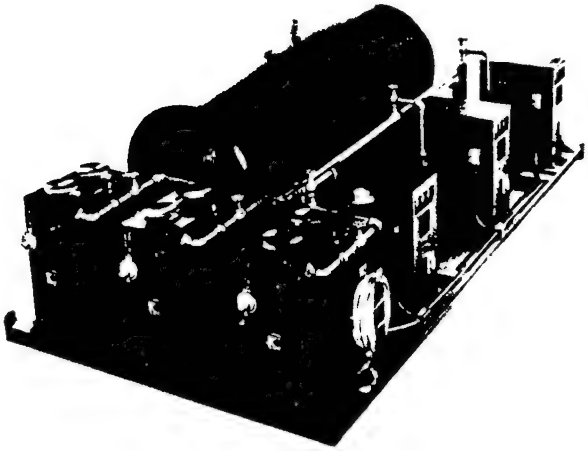
BTU/CF	% Propane	% Air	Specific Gravity
1200	47	53	1.246
1400	55	45	1.287
1450	57	43	1.297
1500	59	41	1.308
1560	61	39	1.320

Table 3. VAPORIZER SPACING

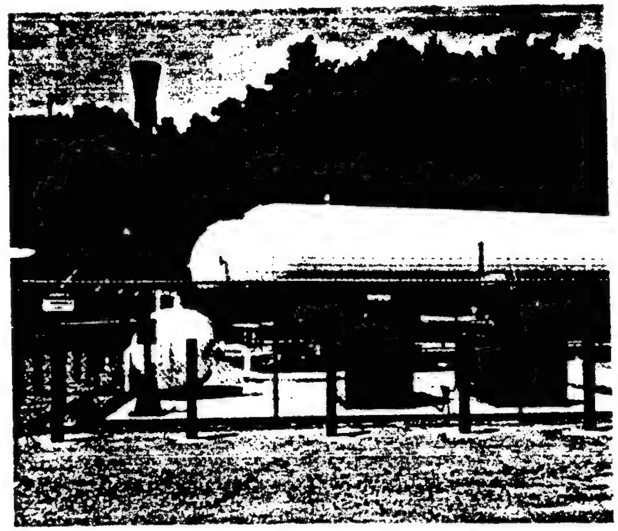
Exposure	Minimum Distance Required
Container	10 feet
Container shutoff valves	15 feet
Point of transfer (See 4001)	20 feet
Nearest important building or property line	25 feet

Table 4. TANK HEATER SPACING

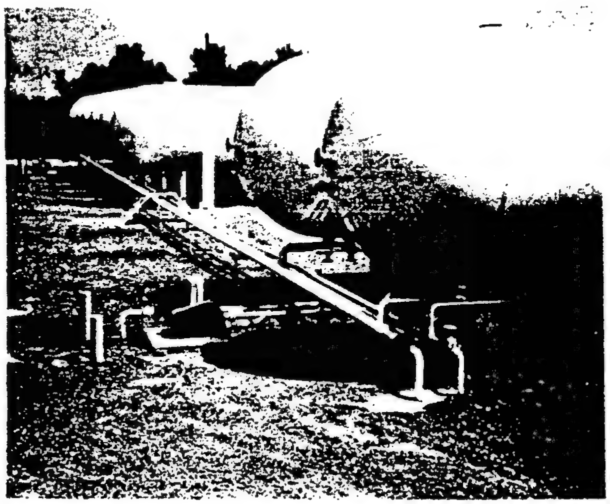
Container Water Capacity	Minimum Distance Required
500 gallons or less	10 feet
501 to 2000 gallons	25 feet
2001 to 30,000 gallons	50 feet
30,001 to 70,000 gallons	75 feet
70,001 to 90,000 gallons	100 feet
90,001 to 120,000 gallons	125 feet



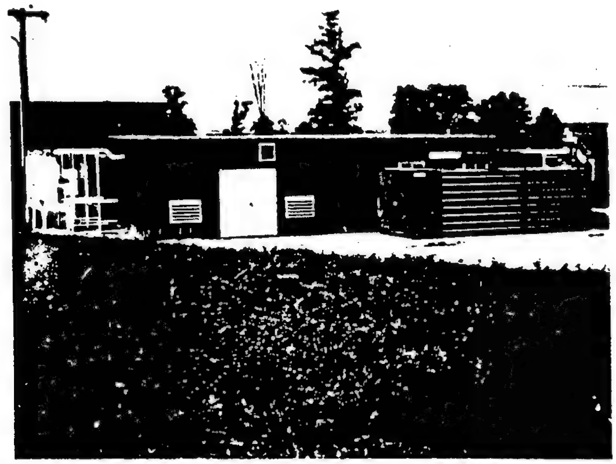
Packaged components of a system include the surge tank, vaporizers in foreground, blenders in rear.



A typical industrial installation comprises storage tanks, small surge tank, blenders, vaporizers.



An example of a very large industrial installation, incorporating eight 60,000-gal. tanks.



In many large installations (as at left), blender, controls, air compressors are inside a building.

to vehicular traffic it must be buried not less than 2 feet below grade or otherwise protected against damage.

How To Install. Two schematic views illustrate recommended methods of installing underground tanks. *Fig. 1* illustrates methods of burying and protecting a tank in a driveway or parking lot. *Fig. 2* shows the traffic collar for driveway installation. *Fig. 3* shows an underground installation in a planted area. When installing the piping and the regulator in a dome of an underground tank, make sure the regulator is located higher than any possible water level or have a vent tube to keep water out.

The vent tube should be run from the regulator vent to above any possible water level, and the vent tube opening should terminate at the extreme top inside the dome cover and be covered with a suitable screen. Regulators that do not have a topped vent in which to install a vent tube should not be used unless they can be installed above any possible water level.

Fig. 4 is a schematic of an above-ground tank when a vaporizer is used. The schematic traces the liquid service line to the inlet of the vaporizer.

A more detailed drawing of a tank and vaporizer installation, complete with other handling facilities, is shown in *Fig. 5*. Note that the draftsman has shown a complete system, including a tank car siding.

In such an installation, one of several types of vaporizers might be used, including both direct- and indirect-fired. A new type commonly used today is the water-bath type. Sizes and types cover a broad spectrum from small, integral direct-fired units ready to install in the system to multi-component equipment that must be tailored for the job. Typical of the smaller integral systems is a gas-fired model that will vaporize 40 gph of propane at temperatures as low as -40°. This size has many applications in commercial applications, particularly, such as schools, motels, hospitals, grain dryers, restaurants, etc. The larger units such as the one shown in the schematic drawing have many times this capacity, of course.

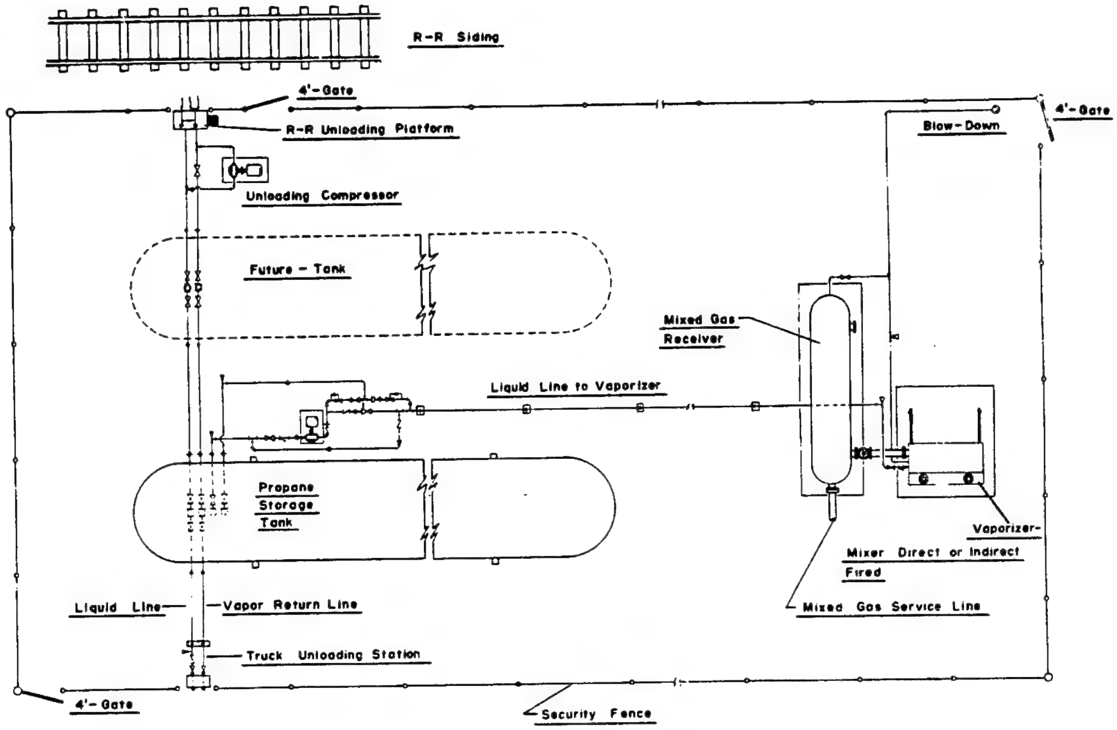


Fig. 4. ABOVEGROUND TANK AND VAPORIZER INSTALLATION

Each size and type of vaporizer is designed for a specific range of demands. To determine which type is best for the application you have in mind check your local propane marketer.

Be sure to comply with local regulations regarding installation of vaporizers. NFPA 58, "Storage and Handling of Liquefied Petroleum Gases," lists a number of locations where vaporizers may be installed. However, certain minimum distances must be maintained between direct-fired vaporizers and certain components of the system as well as nearby buildings and property lines; these are shown in *Table 3*. Similarly, direct gas-fired tank heaters must be placed at specified distances (see *Table 4*).

Propane is the logical choice as a standby fuel for natural gas. The system is comparatively simple, no adjustments to plant equipment are needed to effect the changeover, and the equipment simply won't know the difference between the two fuels. You can minimize your customer's fuel problems by specifying propane. ■

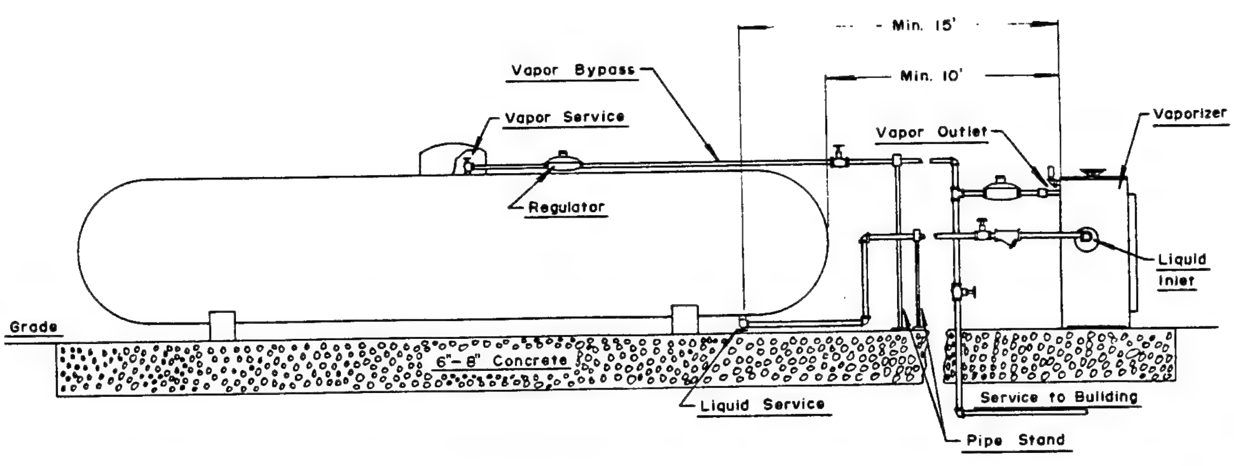


Fig. 5. SCHEMATIC OF INSTALLATION WITH VAPORIZER

LP GAS AS AN ALTERNATIVE

WHY ALTERNATIVE FUELS ARE NEEDED

The need for alternative fuels has become apparent in the past several years, due to the volatility of pricing and supply in the industrial sectors.

Industries today are either faced with high price base fuels, natural gas, propane, or oil or shortage of one or the other. The shortages being caused by the lack of supply or the withholding of supply from the market place such as the oil crisis when OPEC exercised their right not to supply the world with fuel when needed. Today however, curtailments, shortages and high prices are the rule, rather than the exception. Even plants on firm contractual rates with utilities and other suppliers are faced with curtailments and shortages, therefore, it is a prudent business decision to have more than one fuel available to operate the industrial sector. Many companies are using propane as their primary or secondary fuel.

The ability to utilize the lowest cost fuel or to insure availability, provides the need for alternative fuel systems. Even the rare possibility of an accidental outage of primary supply could cause sufficient damage and be disastrous to some firms, for example an operator of four ceramic furnaces, needed a secondary system to protect his elaborate product which had to be cooled at a controlled rate. In one case, a ruptured natural gas main caused the ceramic kiln to fail, resulting in the necessity to reline a furnace and the loss of product. With four other such furnaces to consider, the operator installed secondary fuel equipment even though he was buying gas on a firm rate. The plant has now been enlarged, with consumption increasing to the point where it is eligible for the interruptable rate. The alternative fuel system now serves a two-fold purpose:a replacement for interruptable fuel and as insurance against accidental outage.

In another example, several large airlines installed computer centers utilizing total energy systems which were operated by gas turbines. These computer centers required their own power system to provide a closer frequency and voltage control than that provided by public power. Public power, therefore, could not be used as standby. The airline, although on a firm natural gas rate, purchased a propane gas system, since even a short term natural gas failure could result in the computer failure and loss of data.

CHOOSING A FUEL

Economy dictates to a large degree the choice made for primary or alternate fuel. Boilers in many applications have been switched from their original fuel's, oil and, coal to using natural gas. In many cases, once this equipment has been converted, the standby fuel normally becomes the original fuel for the boiler.

However, the old oil or solid fuel-burning equipment normally is antiquated and storage and handling equipment has deteriorated, the necessity to replace all facilities simultaneously justifies a change to a better, more economical fuel. This is especially true if the consumer has kept accurate records. These will show that the maintenance of burning and handling equipment for fuels other than natural gas or propane is considerably higher.

Cleanliness plays an important part in the selection of a fuel. A manufacturer of electronic specialties, for instance, had to maintain "clean rooms" where incoming air was meticulously filtered to prevent airborne solids from destroying or downgrading the finished product. Solids emitted from the boiler while burning oil during gas cutoffs were found to be fouling filtration equipment. This consumer converted to LP Gas as an alternative to oil.

Many plywood manufacturers, having had to bleach their veneer after using oil-fired dryers, discovered that this cost justified the change to an LP Gas (propane) system which eliminated the need to bleach.

Another significant factor in the selection of fuel is contamination, particularly in food processing. Natural gas has long been used in direct gas-fired dryers for the production of powdered dairy products. In this process the only alternative fuel which can be used is LP Gas.

In the past 10 years, approximately 70% of the facilities installed have utilized straight propane rather than a mixture of propane and air which is used to replace natural gas. In these installations, primarily industrial plants, gas burning equipment consists of powered burners, large in size and few in number. In many cases the burners can easily be adapted to straight propane by the simple expedient of lowering delivered pressure to the burners.
In one application a large boiler system was fired with propane and # 2 oil was used as a standby. In another instance propane was the primary fuel for aggregate drying. In both applications propane was picked because of its cost and utilization advantage.

Switchover from one fuel to the other entails a somewhat complex procedure and technical knowledge on the part of the operator. Most large plants, however, have staff members with the expertise to effect these changes. Where gas is the primary fuel depending on the layout of the gas distribution system, such facilities can be divided to burn raw propane in the large burners and a propane air mix in the smaller devices employing atmospheric burners.

Now, however, a greater number of commercial and institutional facilities require alternative equipment. Most of these plants employ gas burning devices not easily adapted to two different fuels and few have the maintenance personnel required to perform complex changeover procedures. Economics dictates the use of less sophisticated firing equipment in these facilities, which makes the use of a compatible secondary fuel (propane/air mix) mandatory. While it is possible to use straight propane in any of these facilities by changing orifices in atmospheric burners and duplication gas regulation equipment on the power burners, it is obviously impractical to do so in a system where there may be anywhere from 10 to 100 such units. The physical time required to perform the change, plus such items as line purging, makes the use of anything but a compatible mixture totally impractical.

WHAT IS A COMPATIBLE MIXTURE

A compatible mixture can be defined as propane and air with a heating value of 1,400 BTU/cu. ft. and a specific gravity of 1.3 (approximately). Confusion reigns, even within the industry itself, in regard to compatibility. There have been at least five different methods of calculating the characteristics of compatible fuel which have been presented in up to 20 technical papers. Regardless of the method of computation for the resulting figures, ultimately the purpose is to provide a gas that will burn in the same devices and in the same manner as natural gas.

Although a compatible mixture is transmitted in the same pipeline as natural gas, through the same meters, regulators and orifices, at the same pressure, burns in the same manner and in the same burners, it does not even approach its chemical and physical characteristics.

Natural gas is lighter than air, contains roughly 1,000 BTU/cu. ft. and has a specific gravity of about 0.6. Propane is half again as heavy as air and contains approximately 2,520 BTU/cu. ft.

While a mixture close to the physical characteristics of natural gas would be possible by mixing propane and hydrogen, this is obviously unrealistic. For any practical consideration, propane must be mixed with air. And since air has a specific gravity of 1, any mixture of the two would have a specific gravity between 1 and 1.5.

The characteristics of gas flow through an orifice are such that this heavier product (the compatible mixture) will flow at a lower rate through a given orifice and, in an atmospheric burner, will entrain different amounts of air. Since it is to use the same burner as the natural gas, adjustments must be made to entrain the correct amount of air and provide the same capacity. To compensate for the lower flow rate, a mixture higher in heating value than natural gas must be produced. Thus a compatible mixture of propane and air can be regarded as one with a heating value of 1,400 BTU. cu. ft. and a specific gravity of 1.3 (approximately).

SELECTION OF EQUIPMENT

All systems have on thing in common. The storage facility size depends on availability of fuel from suppliers, duration of use, available space for installation and finally the cost.

Propane Storage tanks are available for both above and below ground installations. The latter are most often found in smaller systems and are used for aesthetic purposes. Above ground tanks are generally recommended for industrial installations.

Refrigerated LP Gas storage is only justified in very large terminal installations.

Codes require different fitting arrangements for various size tanks. Those above the 2000-gallon size require different fittings than for 2000-gallon and smaller. Suggested specifications are available for all sizes in both above and below ground tanks.

The storage tank must be an ASME approved pressure vessel with safety relief valve, temperature, pressure, and liquid level gauges; and with all openings valved and protected by an excess flow valve. This device minimizes the hazards of accidental line or hose breakage. Closing at a predetermined flow rate, it allows only a small amount of liquid or vapor to bleed through until the emergency condition has been corrected.

The tank can be filled by use of adapters common to the LP GAs industry from either a truck or rail car especially designed to transport Liquified Petroleum Gas. Since many trucks carry their own pumping devices and nearly all have their own hoses, adapters are often the only additional equipment required.

VAPORIZATION FACILITIES

LP Gas is ideal for all types of loads. Often the addition of a gas regulator to the storage tank is all it takes to constitute an LP GAs system. Since LP Gas must be stored under pressure to maintain its liquid form, vapor can be withdrawn from the storage tank top, regulated to the desired pressure, and transmitted to burning equipment through gas distribution lines. This method is commonly employed in domestic, commercial, and industrial applications where the load demands.

The boiling point of propane is approximately $-44^{\circ}F$ at atmospheric pressure. As a result, boiling of the liquid takes place any time the storage system is in an atmosphere with a temperature higher than $-44^{\circ}F$.

Heat is absorbed from the atmosphere as the liquid boils until pressure within the vessel rises to a value equal to vapor pressure at ambient temperature. A good analogy is comparing this action to that of producing steam from water in a steam boiler. The main difference is that water boils at $+212^{\circ}F$ at sea level atmospheric pressure. As water in a steam boiler boils, steam pressure increases only as long as heat is being supplied. A propane storage vessel is designed for a working pressure of 250 PSIG. To raise the vapor to that pressure, propane would have to be at a temperature of approximately $128^{\circ}F$. Since atmospheric temperatures rarely exceed $110^{\circ}F$ and the tanks are usually painted with light reflecting paint, inside temperatures above $120^{\circ}F$ are rare. Should such a temperature be reached, safety relief valves in the tank relieve pressure above 250 PSIG. Boiling point temperatures at various pressures can be found in the tables of thermodynamic properties of saturated propane and butane.

Large commercial and industrial facilities require some artificial method of vaporization, since atmospheric temperature is a limited source of heat. There are two basic types of vaporization facilities, direct fired and indirect fired.

The direct-fired vaporizer is a small pressure vessel into which liquid propane is introduced by drawing from the bottom of the propane storage tanks. Immediately under this reactor like vessel is a small burner system (similar to that used in domestic furnaces) producing heat which is transferred through the walls of the vessel into the liquid propane causing vaporization. This vapor is then withdrawn from the vaporizer top through a regulator and into the system.

The danger of direct flame impinging on a vessel containing flammable material limits application of the direct-fired vaporizer. All insurance underwriters and local governing bodies restrict use of the direct-fired vaporizer, particularly with regard to location.

The indirect-fired vaporizer uses an intermediate source of heat which is transmitted to the liquid vaporizer in the form of steam or heated liquid. The simplest, most economical system is one which uses steam. Plant steam is supplied to the vaporizer and the resulting condensate usually discarded.

When a complete system is required, the Hydrothermal Vaporizer with an integral heat source is employed. This system uses a burner which heats water glycol mixture by means of an immersion tube in a configuration similar to a fire tube boiler. Immersed in the heated fluid above the fire tube is the propane vaporization coil. Its location here is the key to the safety and control capabilities of the indirect-fired vaporizer. Another important advantage is the fact that temperature can be limited or controlled easily. With direct-fired equipment, impingement of flame on vessel walls causes high localized temperatures resulting in cracking of of the propane. This causes heavy ends to form. These heavy ends when carried through the plant piping, cause a number of problems from, decreasing system capacity to malfunctioning of the system.

Vaporizers do not control or add any usable pressure to an LP Gas system. Therefore, a liquid pressure stabilization pumping system is needed when minimum ambient temperatures will not provide sufficient tank pressures. Packaged pressure stabilization systems are available and these should be located as close to storage as is practical. LP Gas in storage is always at its boiling point and will flash with any reduction of pressure.

MIXING AND DISTRIBUTION FACILITIES

The storage system and vaporizer may be all that is required when straight propane can be used as a standby fuel. In other cases a third major component, the air-gas mixer, must be added.

There are two primary types of mixing equipment: the venturi compressor and the proportioning valve. The former employs the kinetic energy of propane to induce air at a fixed ration. This is accomplished by introducing high pressure propane vapor into a nozzle containing a characterized orifice. As the propane leaves the orifice, a suction is produced at the air inlet which induces air. The resulting mixture is compressed to a controlled pressure. The venturi compressor system has the advantage of pulling air from the atmosphere and producing a mixture as high as 10 PSIG. The need for air compression and drying equipment, usually the most expensive components of a standby facility, is thus eliminated.

The other system, the proportioning valve type, requires compressed air regardless of the desired mixture pressure. This system consists of an air regulator, which provides air at closely controlled pressure and pilots a regulator to provide propane vapor at exactly the same pressure. The air and vapor then enter a mixing valve which is characterized to produce a fixed gas/air ratio throughout the operating range.

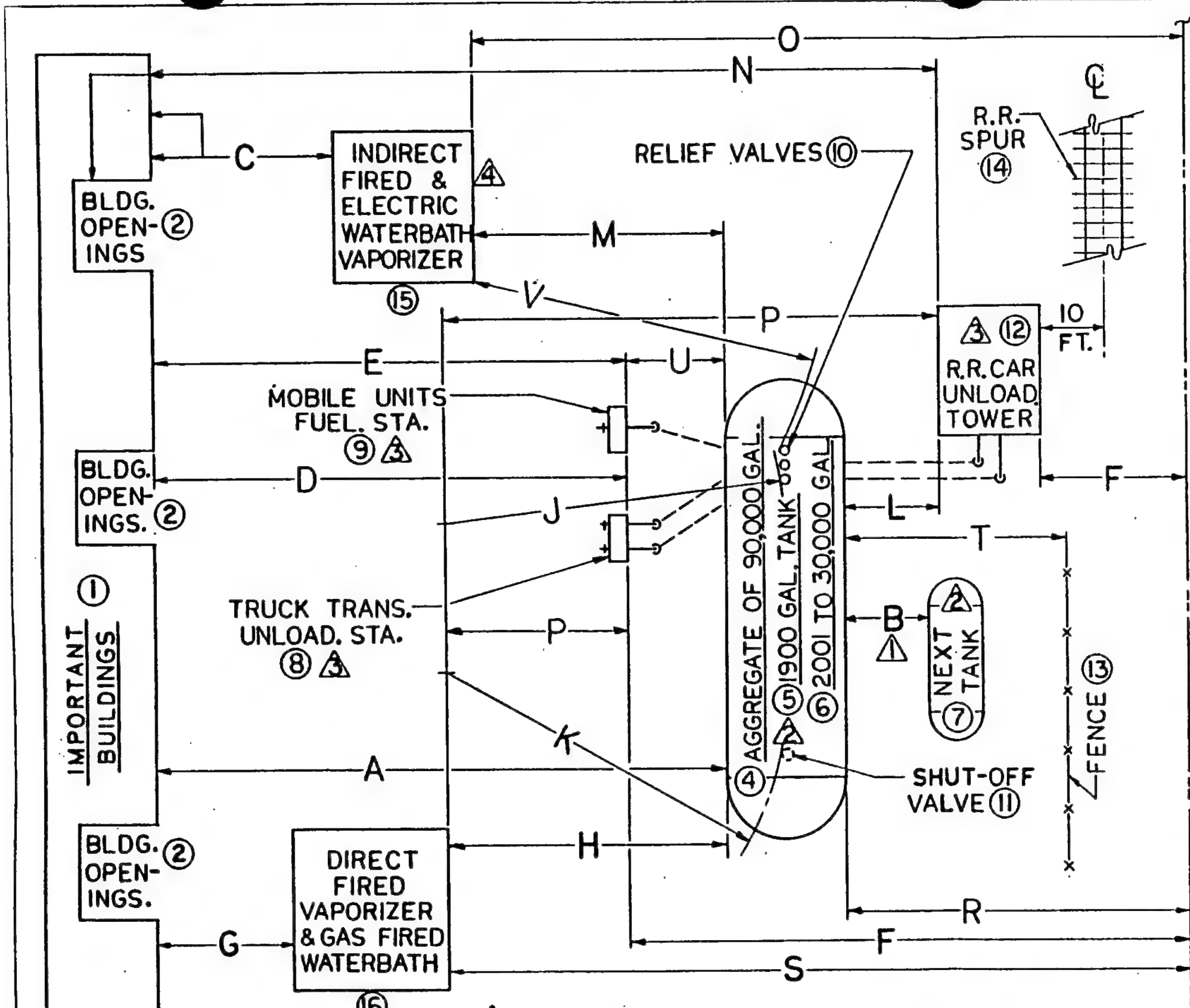
The choice of mixing system is dictated by the desired mixture pressure and to a lesser degree, the output capacity. Whenever a 12 PSIG or lower mixture pressure is satisfactory, the venturi compressor usually proves to be the less expensive choice. For higher pressures, necessitating compressed air, the proportioning valve system is generally more economical.

THE PACKAGED GAS PLANT

Storage/handling, vaporization, and mixing/distribution facilities are the three major components of the LP Gas system. Once these are understood, the next step is selection of the necessary equipment. Final decision should take into consideration the compatibility of the complete system as well as the merits of individual pieces of equipment. Factory tested equipment will assure that construction is consistent with national codes and industry standards. Compatibility of various components with equipment of different manufacturers is another matter.

Selecting all catalogued components from national manufacturers is the best assurance of compatibility. Packaged standby gas plant components are available for liquid pressure stabilization, vaporizing, gas/air mixing, control centers, peak shaving, unloading and storage. Dependability, the most important criteria in LP Gas standby plants, can best be assured by obtaining the full line from a major gas plant manufacturer.

The decision to invest in standby equipment is a big one. Choosing a compatible system suited to individual needs requires the technical expertise and advice of a professional in the field. The information in this booklet should help the potential buyer to understand the basics of standby fuel and equipment and to access his requirements, after which he should obtain the services of a specialist. Doing so generally saves a lot of time, money and trouble.



△1 75 FT.-FM REQ. BETWEEN ADJACENT TANK GROUPS PER AGGREGATE OF 180,000 GAL. GROUP. (MAX. ALLOWED)

△2 ABOVEGROUND ONLY.

△3 POINT OF TRANSFER.

△4 BURNER END ONLY.

△5 CHECK LOCAL CODES WHEN IN DOUBT.

△6 NO DIMENSIONS ARE SPELLED OUT BY THESE CODES.

MINIMUM LOCATION OR CLEARANCE REQUIREMENT △2 △5

DIM.	DESCRIPTION (PT. TO PT.)	DISTANCE IN FEET		
		NFPA 58	FM	IRI
A	1 TO 4	△6	150	150
	1 TO 5	25	25	50
	1 TO 6	50	75	100
B	5 6 TO 7	5	5	5
C	1 TO 15	△6	20	75
	2 TO 15	△6	20	75
D	2 TO 8 9	25	75	100
E	1 TO 8 9	25	50	100
F	8 9 12 TO 3	25	△6	△6
G	2 TO 16	25	50	75
H	16 TO 4 5 6	10	15	75
J	16 TO 10	△6	75	△6
K	16 TO 11	15	△6	△6
L	12 TO 4 5 6	10	75	75
M	15 TO 4 5 6	△6	5	10
N	1 TO 12	25	200	100
	2 TO 12	25	200	100
O	15 TO 3	△6	△6	△6
P	16 TO 8 9 12	15	75	75
R	4 TO 3	100	△6	△6
	5 TO 3	25	△6	△6
	6 TO 3	50	△6	△6
S	16 TO 3	25	△6	△6
T	4 5 6 TO 13	3	△6	△6
U	8 9 TO 4 5 6	△6	50	75
V	15 TO 10	△6	50	△6

PLANT SYSTEMS INCORPORATED
P.O. Box 38308 Cleveland 44138
7993 Lewis Road - Berea, Ohio 44017
(216) 235-5700 Fax: (216) 235-5944

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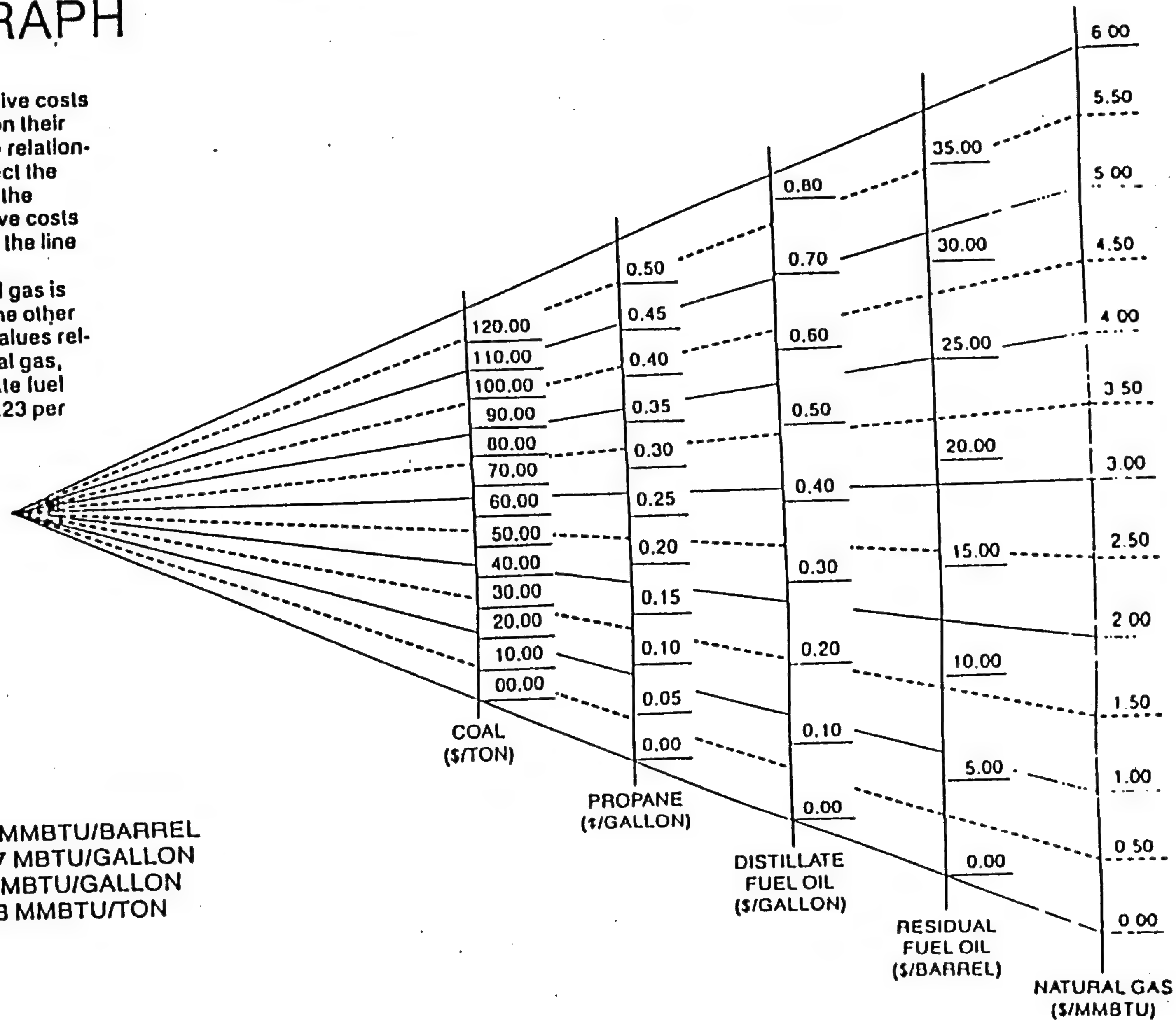
ENERGY PRICE NOMOGRAPH

The nomograph indicates the relative costs of various forms of energy based on their heating values. To determine price relationships, use a straightedge to connect the point where all lines intersect with the known price of one fuel. The relative costs of other fuels will be located along the line of the straightedge.

For example, if the price of natural gas is $2.50 per MMBTU, the prices of the other fuels, derived from their heating values relative to the heating value of natural gas, will be: resid, $15 per BBL; distillate fuel oil, $0.35 per gallon; propane, $0.23 per gallon; coal, $55 per ton.



CONVERSIONS

RESIDUAL .... 6.29 MMBTU/BARREL
DISTILLATE .... 138.7 MBTU/GALLON
PROPANE .... 91.1 MBTU/GALLON
COAL .... 21.98 MMBTU/TON

Source: TEGPL Market Research

MATERIAL SAFETY DATA SHEET

PLANT SYSTEMS INCORPORATED
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WARNING STATEMENT

DANGER! Extremely Flammable.
Vapor reduces oxygen available for breathing and may cause suffocation in confined spaces.
Liquid may cause freeze burn similar to frostbite.

I. Product Identification

Chemical Name: Propane
Synonyms: LP-Gas, Bottled Gas
Chemical Family: Paraffinic Hydrocarbon
Chemical Formula: C_3H_8
DOT Proper Shipping Name: Liquefied Petroleum Gas
DOT Hazard Class: Flammable Gas
DOT I.D. Number: UN1075

800-424-9300 (CHEMTREC)

NFPA Classification:

Health	1	Slightly Toxic
Fire	4	Extremely Flammable
Reactivity	0	Stable

II. Hazardous Ingredients

Component	CAS Number	%	OSHA PEL	ACGIH TLV
Ethane	74-84-0	0-6	None established	Simple asphyxiant
Propane	74-98-6	87-97	1000 ppm (8hr)	Simple asphyxiant
Propylene	115-07-1	0-5	None established	Simple asphyxiant
Butane	106-97-8	0-2.5	None established	800 ppm (8 hr)

III. Physical Data

Boiling Point: -44°F
Melting Point: -309°F
Vapor Pressure: 208 psig (max.) @ 100°F
Vapor Density (Air=1): 1.5
Specific Gravity (H_2O=1): 0.504

% Volatile by Volume: 100%
Solubility in Water: Insoluble
Evaporation Rate (Bu Ac=1): N/A
Gas Volume @ Atm. Pressure & 60°F (Cu. ft. gas/gal. liquid): 36.4

Appearance and Odor: Colorless liquefied petroleum gas. Odorless in pure form. Propane sold for fuel contains a foul smelling, skunk-like warning agent (odorant). The odorant is effective, but the ability of people to detect odors varies widely. Also, certain chemical reactions in the propane system can reduce the propane odor level. No odorant can be 100% effective in all circumstances. If odor level appears to be weak, notify your propane supplier immediately.

IV. Fire and Explosion Data

Flash Point (Method Used): -156°F (estimated)
Flammable Limits (% Volume in Air): Lower 2.1% Upper 9.5%

Extinguishing Media: Dry chemical, foam or CO_2 for small fires. Stop flow of gas first.

Special Fire Fighting Procedures and Precautions: Evacuate area. Notify fire department. Allow only properly protected personnel in area. Shut off source of gas, if possible. Allow fire to burn until gas flow is shut off. Adequate water stream can be used to cool exposed equipment and vapor space of containers. Approach a flame enveloped container from the side, never the head ends. For massive, uncontrollable fires and when flame is impinging on vapor space of containers, withdraw all personnel and evacuate surrounding vicinity immediately.

Unusual Fire and Explosion Hazards: Products of combustion may yield carbon monoxide. Uncontrolled vapors spread rapidly, are heavier than air and are extremely flammable.

V. Reactivity Data

Stability: Stable
Materials to Avoid: Strong oxidizing agents
Hazardous Decomposition Products: Incomplete combustion can cause carbon monoxide.
Hazardous Polymerization: Will not occur

VI. Health Hazard Data

Product is not listed as carcinogenic by NTP, IARC or OSHA. Product may contain a trace, but detectable amount of benzene, a chemical listed by the State of California and known to cause cancer or reproductive toxicity.

Routes of Entry / Acute Effects of Overexposure:

Inhalation: Exposure to high concentrations of the vapor causes dizziness, drowsiness, nausea or unconsciousness due to anesthetic properties.

Skin Contact: Liquid can cause freeze burns similar to frostbite if contact with skin occurs. No skin absorption is expected.

Eye Contact: Liquid can cause freeze burns if contact with eyes occurs.

Ingestion: Ingestion is not expected to occur in normal use.

Chronic Effects of Overexposure: No abnormal reactions reported following exposure to 1000 ppm for 8 hours per day, 5 days per week, for 2 weeks.

VII. Emergency and First Aid Procedures

Eye Contact: Flush with water. Obtain medical assistance if contact with liquid has occurred.

Skin Contact: If freeze burn occurs, remove contaminated clothes, shoes and jewelry. Immerse burned area in warm (not hot) water. Keep immersed. Call for medical assistance.

Inhalation: Remove victim from further exposure and into fresh air. Provide oxygen if breathing is labored. If victim is unconscious, seek immediate medical attention. If breathing has stopped, give artificial respiration.

Ingestion: Not expected to occur in normal use.

VIII. Spill or Leak Procedures

Product is extremely flammable. If there is a leak but no fire, do not ignite the gas. Eliminate all ignition sources. Evacuate the area. If possible, remove leaking container to safe area. Stop flow of gas or allow vapor to disperse in a safe area. Use water spray to help dilute vapor concentration in the air.

Dispose of gas only by controlled burning in compliance with local laws and regulations.

IX. Handling and Storage Precautions

Store in an authorized location (outside, detached storage is preferred) with adequate ventilation. Keep away from heat and ignition sources. Inspect cylinders frequently for leaks, dents, gouges and corrosion with emphasis on bottom of cylinder. Store cylinders in upright position or with pressure relief valves in vapor space. Do not drop or abuse cylinders. Keep container valve closed and plugged when not in use. Install protective caps when cylinders are not connected for use.

X. Personal Protection Information

Ventilation: Use adequate ventilation to maintain exposures below recommended limits.

Respiratory Protection: Use a NIOSH-approved respirator if area is thought to contain unknown concentration of gas.

Eye Protection: Use safety goggles or safety glasses with side shields.

Protective Clothing: No special garments are necessary, but avoid skin contact with liquid because of possibility of freeze burn. Propane resistant gloves are recommended.

XI. Communication with Employees and Purchasers

This Material Safety Data Sheet (MSDS) alerts the reader to the potential safety and health hazards of propane. It also contains valuable reference material relating to the safe use and handling of the product. Make sure that this information is shared with all employees and purchasers who use or handle the product. It is an important part of the OSHA hazard communication program.

LT81A Insertion Mass Flowmeter

Originally designed to meet the stringent requirements f nuclear power plant applications, the LT81A has be- ome FCI's most frequently specified Mass Flowmeter. Its ide turndown, broad selection of insertion-type mounting onfigurations and outstanding record of reliability provide nequaled versatility for gas flow metering in numerous in- ustrial applications.

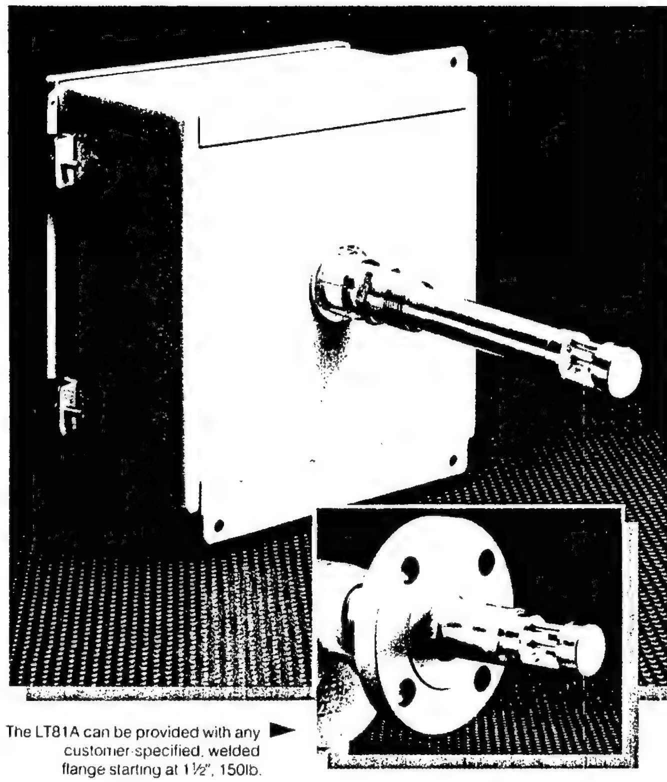
The LT81A is available with a 1" or 1¼" MNPT threaded onnection, flanged or packing gland connection, and in- ertion lengths up to 30" (9m) for convenient installation in ny line with a minimum 1¼" inside diameter.

Repeatability of ± 1% over 800:1 turndown, accuracy of ± 1% of full scale and no-moving-parts operation assure recise, reliable mass flowmetering of gases and gas mix- ures over an exceptionally wide flow rate range at pres- ures from vacuum up to 1250 psig (104 bar) – higher on pplication.

For most applications, the all-metal 316 Stainless Steel/Nickel Brazed sensor probe construction offers uperior resistance to corrosion and abrasion. However, Ha[illegible]y C/Gold Braze can be optionally provided for dd[illegible] protection in extremely harsh media.

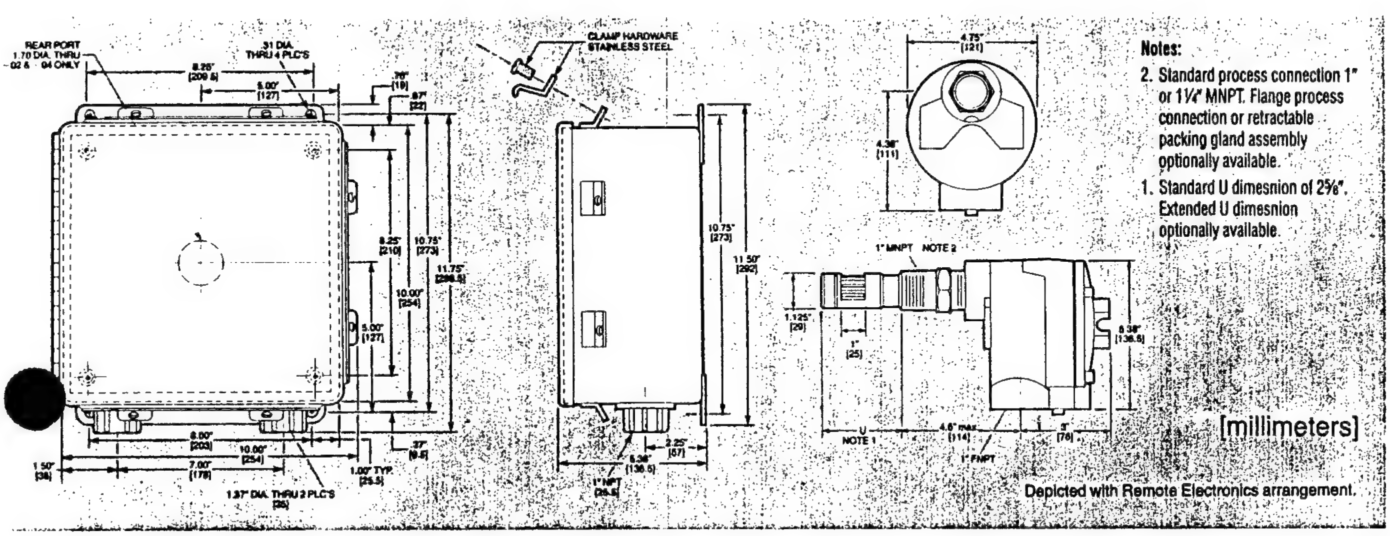
The sensor probe is mounted to a NEMA 4 enclosure which houses all electronic circuitry. A Remote package is also available where process conditions or convenience dictate separation of the sensing assembly from the instru- ment's electronic circuitry. (See Page 7.)

The LT81A High-Temperature model with Remote Elec- ronics package and fiber glass jacketed interconnecting able should be specified for operation in process temper- atures exceeding 350°F (178°C), up to 850°F (458°C).



The LT81A can be provided with any customer-specified, welded flange starting at 1½", 150lb.

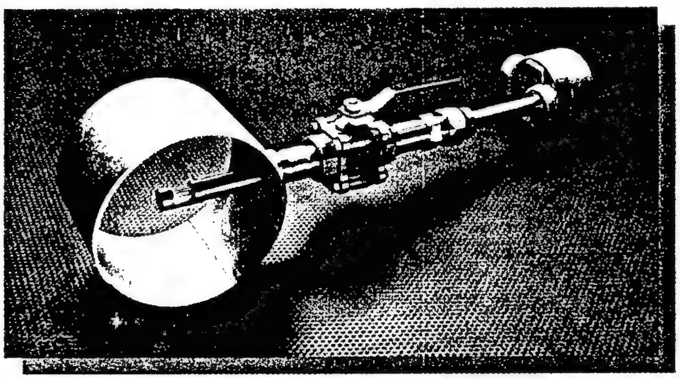
Available linearized signal outputs include the standard 4-20mA, or optional 10-50mA, 0-10VDC, 0-5VDC, or 1-5VDC. A Flow Rate Indicator and Totalizer with LCD digital displays are optionally available and can be scaled in mass flow, volumetric, or velocity values for instantaneous and total flow indication.

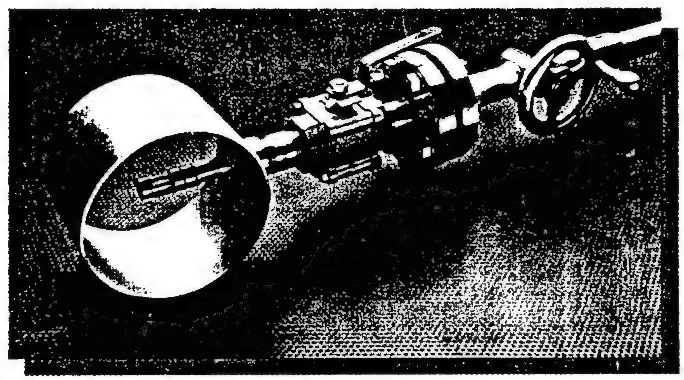


Packing Gland Assemblies

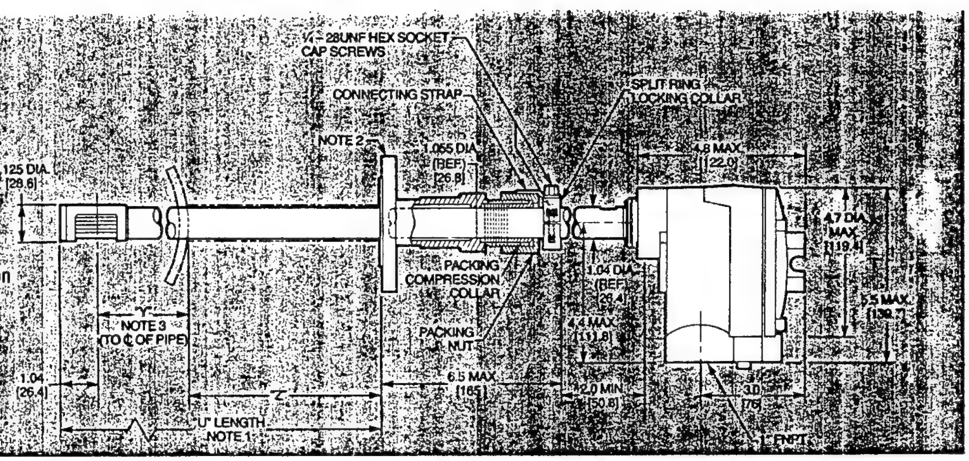
LT81A Mass Flowmeters can be provided with a low, medium, or high pressure packing gland that is ideal for installation and removal without process shutdown.

The low pressure model (shown on left) is suitable for line pressures up to 50 psig (3.5 bar). The medium pressure model is rated up to 500 psig 35 bar), the high pressure model (shown on right) up to 1500 psig (104 bar). The high pressure model is pressure-balanced for safe, easy crank-in installation and removal and is designed to remain securely positioned in the line once installed.



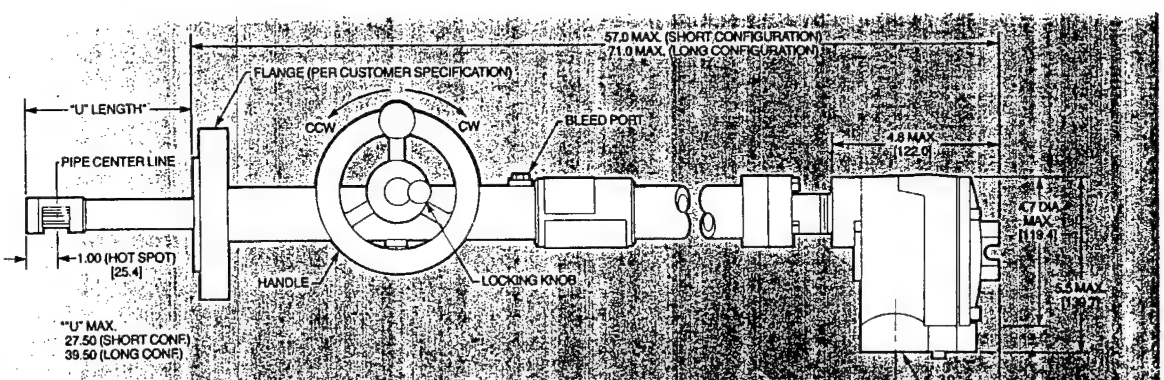


Low Pressure (to 50 PSIG) Packing Gland Assembly, Flanged



NOTES:
3. Model LT81 Transmitters are calibrated for installation at centerline of pipe. Installations off centerline may compromise calibration accuracy.
2. 1½" – 150# or larger flange must be used.
1. "U" length to be specified by customer.
"U" = (Y + Z + 1.04)

[millimeters]



Pressure Balanced High Pressure (to 1500 PSIG) Packing Gland Assembly

An Interim Review Meeting to discuss the Governments comments prior to the final issue of this study report was conducted on August 27, 1992, at the Directorate of Installation Support (DIS) offices at Fort Gordon, Georgia. A list of the attendees at the meeting and copies of the comments discussed are included in this Appendix K.

Responses to and resolution of the comments are as follows:

TRADOC ENGINEER PROJECT REVIEW COMMENTS by Greg Capra, dated 25 AUG 92

Comment 1	There will be continuing discussing between Fort Gordon and Atlanta Gas Light (AGL) to negotiate greater cost sharing by AGL or alternate methods for supplying natural gas to Fort Gordon to eliminate the gas line relocation costs. The final report will include additional LCCA analyses assuming no pipeline relocation costs. The DD Form 1391 will include pipeline relocation costs.
Comment 2	It was agreed that the size of the propane storage would be reduced to 10 days (instead of 30). All costs and economics will be revised accordingly.
Comment 3	Comment was withdrawn. The storage location is shown on the drawings in Appendix D and there are separate comments regarding fire protection from the Fort Gordon fire chief.
Comment 4	TRADOC furnished text file for new LCCA summary sheet to be used in final report.
Comment 5	The "Additional" paragraph will be included on DD Form 1391 per direction given at meeting.
Comment 6	Cost estimates and LCCA analyses will be revised per the comment.

Comment 7	DD Form 1391 will be revised in accordance with comment. MILCON cost index of 1.09 was furnished for mid-year FY95 construction costs. This index will be used for escalation.

PROJECT REVIEW COMMENTS by Curtis D. Oglesby, dated 24 AUG 92

Item 1	Paragraph 4.4 will be modified per the comment
Item 2	Paragraph 4.8 will be modified per the comment
Item 3	The buildings identified in the comment will be deleted from the list of future gas users in Appendix C.
Item 4	The "estimating contingency" was used to include costs such as those listed. The cost estimate detail sheets in Appendix F will be modified for clarification.

PROJECT REVIEW COMMENTS by FPPD, William R. Walker, dated 8 AUG 92

Item 1	A fixed water spray system fill be added to the propane storage tank area.

TRADOC ENGINEER
PROJECT REVIEW COMMENTS

AV: 680 EXT COM: (804)727-Ext.

INSTALLATION	DATE	Page of Pages
Fort Gordon	25 Aug 92	PROJECT NUMBER
PROJECT LP Gas Stoarge Facility		

CMT NO	DRAWING NUMBER PARA NUMBER	TECHNICAL COMMENTS Comments made by Greg Capra, TRADOC, (804) 727-2441
1	Page 5-3	If Atlanta Gas Light (AGL) could benefit from installation of gas line around the east and north perimeter of the fort by gaining the opportunity to supply new customers, contact AGL to see if they will share cost. Port Jackson's gas company has agreed to pay a rebate for Jackosn's LP gas storage project. Also Fort Eustis was able to negotiate with Virginia Natural Gas to install all piping at no cost.
2	Pg 4-8, Design Information	The recommended size of storage is based on a thirty day supply of propane. There is no regulation requiring family housing to have a minimum of 30 day back-up fuel supply. The requirements for 30 day fuel storage in AR 11-27 and AR 420-49 applies to central plants over 5 MBTUH. Recommend the DIS reconsider the amount of storage.
3	General	The study does not state the location for the proposed facility. Additional information should be provided concerning the location of the facility. Recommend coordination with the local fire chief for determination of additional interpretation of NFPA 58. Depending on the location a fire sprinkler system may be required.
4	ECIP Criteria	Request the DD Form 1391, Front Page, and life cycle cost analysis (LCCA) summary sheet be revised based on new ECIP guidance. Will provide copy at review meeting. Guidance includes a revised LCCA summary sheet which eliminates the non energy qualification test and changes the economic life from 25 to 20 years.
5	DD Form 1391, Additional Para	Need to add the "Additional" paragraph. Paragraph must state the project has been coordinated with physical security and state how the savings will be verified each year for the life of the project.
6	LCCA Summary Costs	A. Construction cost — Use estimated construction cost (current dollars) + same contingency shown on front page (usually 7.5 and 10%). B. SIOH — same as front page of DD Form 1391. C. Design cost — 6% of construction cost plus contingency. d. Public Utility Rebate — Amount utility company is will to pay to support project.
7	DD Form 1391 Costs	A. Construction cost — Use estimated construction cost escalated to mid year of construction using the Tri-Services MILCON Indices. B. Contingency use 7.5%. C. SIOH — Use 6%. D. Total Requested Amount — Round to nearest $10K.

PROJECT REVIEW COMMENTS
DATE: 24 Aug 92
TO: Dennis Lindemeier
FROM: Curtis D.Oglesby
PROJECT: Ft. Gordon LPG Study
YEAR:
LINE ITEM NO.:
TYPE OF ACTION: Interim Submittal Review

ITEM NO.	DRAWING NO. OR PAR. NO.	COMMENTS
1.	Par. 4.4	The buildings scheduled for demolition are currently in use, except those buildings scheduled for demolition this year.
2.	Par. 4.8	Current total of 231,455 MMBTU/Hr is actually the total of current connected load to be backed up. There is current connected load that requires firm gas until these buildings are demolished in future.
3.	Appendix C	SATCOM II - Total electric computer facility Soldier Service Center - Served by Plant 25910
4.	Appendix F	Cost estimate to include fire, safety, security, site prep and electrical costs

TOTAL P.02

PROJECT REVIEW COMMENTS	DATE: 8/26/92	PAGE 1 OF 1
TO: Energy Engineer, FAC DIV, ATTN: Mr. Oglesby	FROM: (SECTION) FPPD (REVIEWER) William R. Walker	
PROJECT: Liquefied Petrolium Gas (LPG) Storage Facility Study LOCATION: Ft. Gordon, Georgia	YEAR FY –	LINE ITEM NO.: S-E Project No. 7469B

TYPE OF ACTION:		Preliminary		Concept
		Final	X	Interim Submittal

ITEM NO.	DRAWING NO. OR PAR. NO.	COMMENTS:	REVIEWRER ACTION:
1.		Recommend a fixed water spray system be installed for protection of propane tanks (The water spray system keeps the tanks cool in case of fire, prevents liquid contents from boiling away, and protects the tanks shells against rupture due to localized high temperature flame impingement). Tank failure may occur as early as 10 minutes after flame impingement. The proposed tank storage site limits the response of fire protection equipment to one engine company within the 10 minute time frame. One engine company could not provide adequate quantities of water to prevent container failure from fire exposure.	

Signature Reviewer: William R Walker Approving Official: John Parsons

CONFERENCE PARTICIPANTS

PROJECT: LPG STUDY

CONTRACT NUMBER: DACA 21-92-D-0034/0063

LOCATION: FT. GORDON.

AUGUST 27, 1992

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